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Title:
Individual, social and environmental determinants of sugar-sweetened beverages intake in Mexico

Individual, social and environmental determinants of sugar-sweetened beverages intake in Mexico

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August 2018

A dissertation submitted to the University of Bristol in accordance with the requirements of the degree of Doctor of Philosophy in the Faculty of Social Sciences and Law

Word count: 69,972

Abstract

Background: Obesity is a major public health issue in Mexico. Recent evidence has emphasised that high intake of sugar-sweetened beverages (SSBs) is important for weight gain. There is a lack of information about the factors that influence SSB consumption in Mexico.

Objective: To identify high SSB consumers in Mexico and assess their individual, social, and micro-environmental predictors of SSB intake.

Data and methods: 1) A quantitative secondary analysis of a representative sample of the Mexican population was conducted to assess the demographic/socio-economic profile of different types of SSB consumers. 2) An online questionnaire was administered in a sample of Mexican adolescents to assess the role of individual, social and micro-environmental factors in SSB intake. 3) Qualitative interviews were conducted among adolescents to elicit in-depth information about their SSB intake at the home and out-of-home environments, and their perception of the SSB taxation.

Results: Compared to other groups, Mexican adolescents had higher odds of being heavy SSB drinkers. The online survey indicated that habit strength, taste, home and school availability were important predictors of adolescent SSB intake. Interviews suggested that taste, beliefs of healthfulness of some SSBs, the importance of accompanying meals with SSBs, and family norms promoted availability and consequently intake of SSBs. School availability of SSBs, social relationships and activities, and proximity to minimarkets/shops were perceived to play a decisive role in promoting SSB intake. Adolescents were largely unaware of the tax and perceived that it would not affect their SSB intake, mainly due to low price increases, taste preferences and 'addiction' to SSBs.

Conclusion: Adolescents are the highest SSB consumers in Mexico and a variety of individual, social and physical environmental factors were associated with their SSB intake that should be tackled by future interventions. These findings provide important insights to planning to reduce SSB intake in Mexican adolescents.

Author's Declaration

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's Regulations and Code of Practice for Research Degree Programmes and that it has not been submitted for any other academic award.

Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

Signed: ……………………………………..

Date: ………………………………………

Publications from this thesis

Publications

One journal article has been published from this thesis. A second journal article corresponding to the research presented in Chapter 6 has been submitted to the Journal of Public Health (first revision is under review).

Ortega-Avila, Ana G., Papadaki, Angeliki, and Jago, Russell. Exploring perceptions of the Mexican sugar-sweetened beverage tax among adolescents in north-west Mexico: a qualitative study. Public Health Nutrition, 2017, 21:618–626

Conferences

Public Health England. Public Health Research and Science Conference 2018:

Ortega-Avila, Ana G., Papadaki, Angeliki, and Jago, Russell. Classification of sugar-sweetened beverage consumers in Mexico: a finite mixture model study. Oral presentation

Ortega-Avila, Ana G., Papadaki, Angeliki, and Jago, Russell. Mexican adolescents' experiences around the sugar-sweetened beverages tax: a qualitative study. Poster presentation.

Acknowledgments

First, I would like to thank the Mexico's National Council of Science and Technology, without their financial support this research would not have been possible. I want to thank Yadira Olivas and Tania Chaidez for all their help and support in the recruitment of schools. Thanks to Mark Edwards for providing feedback on my interview questions. Thanks to Renee Mendoza, for your help during data collection and for your friendship all these years. Special thanks to my supervisors Dr. Angeliki Papadaki and Professor Russ Jago for the opportunity and encouragement to pursue a PhD.

The PhD is an intense but regarding journey and it would not have been possible without the many people I had the pleasure to meet. Thanks go to Maria and Nadia, we started this journey together and I would always be grateful for your friendship and company during the first years of the PhD.

Thanks to the ENHS colleagues and friends. Special thanks go to my office mates throughout these four years, Dani, Zoi, Sarah for welcoming in your office and being amazing friends. Thanks to Sahar for your support (and for constantly feeding me). To Jesu, Selene and James, thanks for listening me complain and for your words of encouragement in this last year. Finally, thanks also go to my short-term office mates Laura and Manos.

I would like to thank the Chilean crew for distracting me for my PhD duties and for your support and encouragement these last few months, your various social events kept me sane.

I would also like to thank my family who have always supported me. Mamá y Papá sin su apoyo nunca hubiera llegado aquí. Abuela muchas gracias por siempre estar al pendiente de mi. Thanks to Agus, Lucia and Sofia, you have supported me in your very unique way. Finally, my infinite gratitude goes to Hector, for your ongoing patience, support, advice and encouragement, without you this thesis wouldn't have happened.

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Abbreviations

SSBs	sugar-sweetened beverages
NCD	non-communicable diseases
US	United States of America
NAFTA	North American Free Trade Agreement
HFCS	high fructose corn syrup
FDI	Foreign Direct Investment
WHO	World Health Organisation
ENSANUT	Spanish-language acronym for Mexican Health and Nutrition Survey
SES	Socio-economic status
GNP	gross national product
HLCI	Household Living Condition Index
PA	Physical activity
ED	Energy drinks
BMI	Body Mass Index
RCT	Randomized Control Trial
HDL-C	High-Density Lipoprotein cholesterol
MetS	Metabolic Syndrome
SUA	serum uric acid
TBP	Theory of Planned Behaviour
PBC	Perceived behavioural control
TRA	Theory of Reason Action
EnRG	Environmental Research Framework for Weight Gain Prevention
FFQ	Food Frequency Questionnaire
GIS	Geographic Information Systems
MOH	Ministry of Health
ANSA	National Agreement for Healthy Nutrition [Acuerdo Nacional para la Salud Alimentaría (ANSA) as per its acronym in Spanish]
RQ	Research question
SFFQ	Semi-structure Food Frequency Questionnaire
FMM	Finite Mixture Model
SEM	Structural Equation Modelling
LPA	Latent Profile Analysis
RMM	Regression Mixture Model
BIC	Bayesian information criteria
SABIC	sample-size adjusted criterion
24HR	24-hour recall
BEVQ	Beverage Intake Questionnaire
SRHI	Self-Reported Habit Index
NBR	Negative binomial regression
CFI	Comparative Fit Index
TLI	Tucker Lewis index
RMSEA	Root Mean Square Error of Approximation
MRC	Medical Research Council

ASB	Artificially Sweetened beverages
NEMS	Nutrition Environments Measure Survey
GPS	Global positioning system

Chapter 1 Introduction

This dissertation is an examination of the different factors associated with the intake of sugar-sweetened beverages (SSBs) in Mexico. The main objective is to contribute to the limited literature exploring socio-ecological factors on the intake of SSBs in the Mexican population. This is achieved by analysing the individual, social, and environmental predictors of SSB intake in Mexico.

Understanding the factors associated with SSB intake is crucial from both a public health and an academic perspective. Over the last two decades, the prevalence of obesity and overweight has become a major public health problem in Mexico, affecting 70% of adults, 34% of children and 44% of adolescents. This means Mexico is one of the countries with the highest prevalence of obesity worldwide (Stevens et al., 2012). Although obesity is a complex problem (Finegood, 2012), evidence from the last decade has emphasised the role of the intake of added sugars, mainly from SSBs, as one of the main factors causing weight gain and thereby increasing risk of non-communicable diseases (NCDs) (Ambrosini et al., 2013; Luger et al., 2017; Malik et al., 2013). In 2006, Mexico showed one of the highest per capita intakes of SSBs worldwide (2.6 servings/day, 8oz./ serving) (Singh et al., 2015) and in 2011, it was the country with the highest intake of caloric soda worldwide with 163 litres consumed per capita (Basu et al., 2013; Caballero, 2015; Colchero et al., 2015). In 2016, 33% of the Mexican population reported consuming SSBs daily and 30% to consuming SSBs several times a week, while 85% of school-aged children reported consuming SSBs regularly (Hernández Ávila et al., 2016).

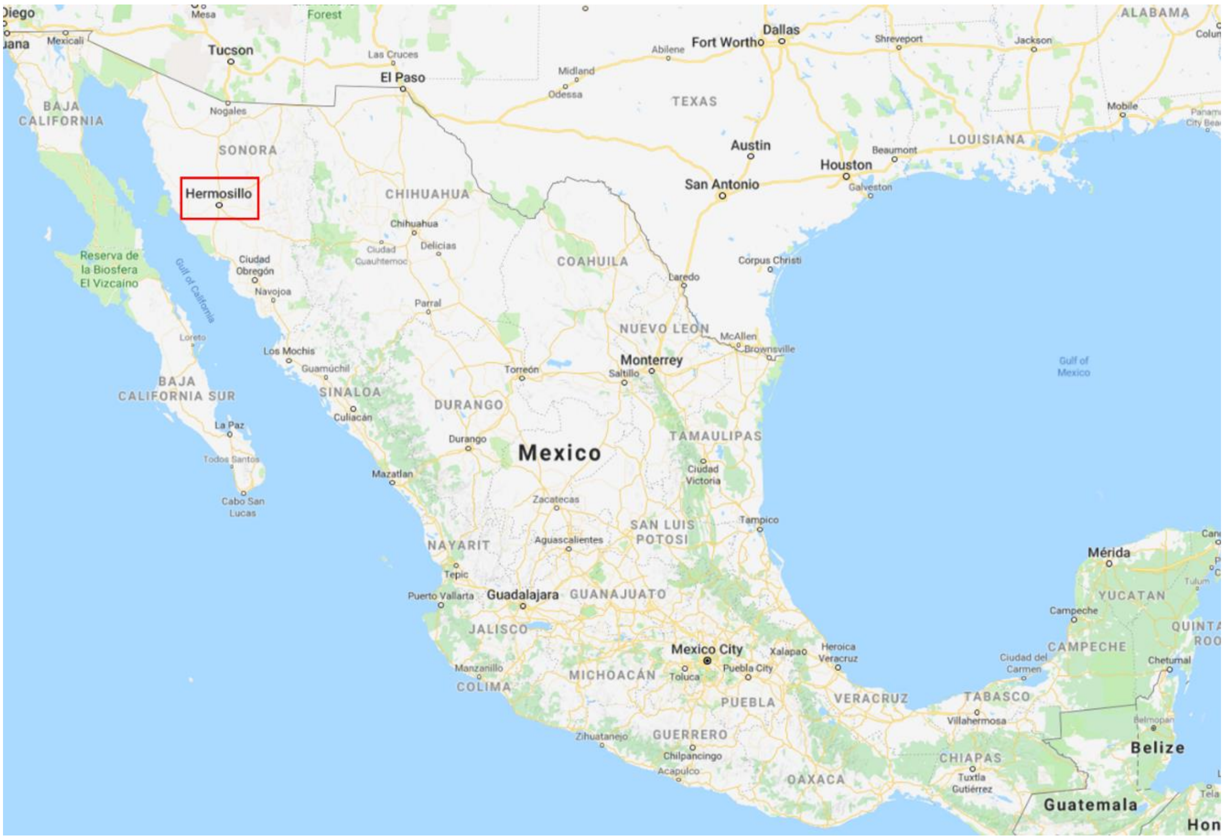
The strategies to reduce the high intake of SSBs in Mexico have been approached mainly from a policy perspective, with the implementation of a nationwide SSB tax in 2014, as well as policies restricting the sale of SSBs in schools (Monterrosa et al., 2015). However, whether SSB tax and school nutrition policies are enough to substantially reduce the intake of SSBs remains a moot point. Also, there is a burgeoning international literature suggesting that the high intake of SSBs must be analysed beyond the pricing of these products, highlighting individual, social, and environmental factors that could be related to the intake of SSB (see Chapter 2). Therefore, assessing the role of these factors on SSB intake in Mexico is important, as it will permit a broader understanding of the intake of SSB among the Mexican population, which could inform the development of multi-level intervention aimed at reducing SSB intake.

This chapter contextualises the problem of SSB intake in Mexico and introduces some key research questions to advance the understanding of this phenomenon. The first section describes Mexico's context in terms of its geographical and economic situation. The second section provides an overview of the health situation in Mexico. The third section describes the obesity and overweight problem in Mexico and briefly reviews the literature on its determinants. The fourth section describes the intake of SSBs across the Mexican population. The fifth section address the theoretical underpinnings of this thesis. The final part of the chapter presents the main objectives and the structure of the thesis.

1.1 Mexico

According to the United Nations (2018) Mexico is a developing, middle-income country. It is located in North America, and is considered part of central Latin America (Singh et al., 2015). Mexico is bordered to the North by the United States (USA) and to the South by Guatemala and Belize respectively, to the East by the Gulf of Mexico and to the West by the Pacific Ocean. Mexico has a mainland area of 1,972,550 km^2, placing it as the 14th largest country in the world (Figure 1). Mexico is a democratic, federal and representative republic whose political administrative is divided in 32 states. According to the national census, the total population of Mexico in 2010 was around 117 million inhabitants (Instituto Nacional de Estadisticas y Geografia, 2013). Around 70% of the population live in urban areas and the rural population is largely scattered along the southern states.

Figure 1.1 Map of Mexico divided up into federal states



A central part of the research presented in this thesis was conducted in Sonora, the PhD candidate's home state, located in Northwest Mexico. Sonora is considered the second largest state in Mexico and is divided into 72 municipalities, where 86% are in urban areas and 14% in rural areas (Instituto Nacional de Estadisticas y Geografia, 2013). The city of Hermosillo is both Sonora's capital and its largest municipality with almost 800,000 inhabitants (Instituto Nacional de Estadisticas y Geografia, 2013).

The location of Mexico is relevant for this research as the proximity to the USA has been decisive in changes in diet and intake of SSBs. An example is the North American Free Trade Agreement (NAFTA) (Gomez-Dantes et al., 2016), which was signed in 1991 and facilitated easier trade between the USA, Mexico and Canada. Whilst Mexico exported fruit and vegetables to the north, the USA exported corn, soybean, livestock, high fructose corn syrup (HFCS) and ready-to-eat food into Mexico. The NAFTA also accelerated Foreign Direct Investment (FDI), which permitted the large-scale entrance of US fast food companies and food retailers, like McDonalds and Wal-Mart to Mexico (Clark et al., 2012). All these economic changes not only affected Mexico's agricultural sector, but also significantly increased the consumption of energy-dense foods (i.e. ice cream, snack foods, soft drinks) and processed meats (Clark et al., 2012), and thus have contributed to the significant rise in obesity, overweight and NCDs prevalence.

1.2 Overview of the health situation in Mexico

Several major changes have been identified in the health status of the Mexican population in recent decades (Gomez-Dantes et al., 2016), which is also referred to as an epidemiological transition (Gomez-Dantes et al., 2016). The epidemiological transition is defined as the shift from the high prevalence and mortality of infectious disease to chronic-degenerative diseases (Stevens et al., 2008; Yusuf et al., 2001). The first signs of the epidemiological transition in Mexico were observed in the 1990s, due to the rapid demographic and income changes that took place during that period (see section 1.1) (Stevens et al., 2008, Beltrán-Sánchez and Crimmins, 2013). Mexico now has a high prevalence of NCDs and NCD risk factors, which account for 75% of total deaths (Stevens et al., 2008). Among the three leading causes of mortality in Mexico in 2016 were cardiovascular disease, diabetes and cancer (Instituto Nacional de Estadistica y Geografia, 2016). Due to the deep-rooted polarisation within the country, characterised by a flagrantly uneven distribution of wealth, education and access to health services (Rivera et al., 2002), the coexistence of communicable diseases with NCDs is a common observation in Mexico. Malnutrition and other infectious diseases still account for 11% of deaths in Mexico (World Health Organisation, 2014a).

1.3 Obesity and Overweight in Mexico

According to the World Health Organisation (WHO), overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health (World Health Organisation, 2018a). Obesity is considered a major risk factor of NCDs such as diabetes, cardiovascular diseases, musculoskeletal disorders (osteoarthritis) and some forms of cancer (World Health Organisation, 2018a).

Obesity and overweight have become a major global public health issue, and research has shown that over a 42-year period (1975-2016), the prevalence of obesity increased in every region and country of the world (NCD Risk Factor Collaboration, 2017). In 2016, overweight affected 1.9 billion adults while obesity affected 650 million adults. It is also estimated that 41 million children under 5 years old and 340 million school-aged children and adolescents are either overweight or obese (World Health Organisation, 2018a).

In Mexico, obesity and overweight have reached epidemic proportions with the country afflicted by the 4th most rapid increase in obese people worldwide (Stevens et al., 2012). Among the adult population in Mexico, the combined prevalence of obesity and overweight increased by 15.4% between 2000 and 2012 (from 61.8% to 71.3%). By 2016, 72.5% of the adult population were obese or overweight, an increase of 1.3% from 2012 (71.2%; CI 95%: 70.5, 72.1). The prevalence of obesity and overweight is higher in women than in men (75.6%; 95% CI: 73.5, 77.5 vs. 69.4%, 95% CI: 65.9, 72.6), and more common in urban rather than rural areas. The prevalence of overweight is higher in Mexico City (41%) than in the Northern, Central and Southern regions of the country. Overall, obesity is higher in the north (37%), compared to other regions. Among the states with the highest abdominal obesity in adults are Baja California (80%), Tabasco (79%), Mexico City (79%), Campeche (79%) and Sonora (78%) (Barquera et al., 2013).

Weight problems also affect the youth population in Mexico, as the combined prevalence of obesity and overweightness in children and adolescents (≤19 years) has shown an increasing trend from 1988 to 2016 (Hernández-Cordero et al., 2017). As anthropometric measures for preschool girls have been available since 1988[1], it has been possible to assess the 24-year trend (1988 to 2012), where an increase of 6.3% in combined risk of overweight, overweight and obesity was observed (from 25.5% to 31.8%, $p<0.001$) (Hernández-Cordero et al., 2017). In

[1] Due to the lack of funding, the national nutrition survey in 1988 was only conducted among pre-schoolers, female adolescents and women, but no school-age children, male adolescents and men. The 1999 survey included school-age children but no male adolescents and men.

2012, the prevalence of overweight and obesity in preschool children (<5 years of age) was 9.7% in both genders (95% CI: 8.9, 10.6) (Gutiérrez et al., 2013).

For school-aged children (5-11years), the prevalence of obesity and overweight increased from 27% to 34% between 1999 and 2012 (Hernández-Cordero et al., 2017). According to the most recent Mexican Health and Nutrition Survey 2016 (ENSANUT from its Spanish-language acronym), the combined prevalence of obesity and overweight in school-aged children was 33% (95% CI: 29.6, 37.1), 1.2% less than 2012 (34.4%; 95% CI: 33.3, 35.6). However, due to the large confidence intervals, this reduction in the prevalence should be taken with caution (Hernández Ávila et al., 2016). A higher prevalence of obesity and overweight among children was observed in urban (35%), compared to rural areas (29%) and in boys (34%), compared to girls (33%) (Hernández Ávila et al., 2016). The prevalence of obesity for children was higher in the North (18%), compared to other regions (Hernández Ávila et al., 2016).

Among adolescents, obesity and overweight from 1988 to 2012 increased from 11% to 36% in females. For males, the data is available until 2006, and shows a small increase in prevalence over the six-year period (from 33 to 34%) (Hernandez-Cordero2017). More recently, results from the ENSANUT-2016 indicated that the combined prevalence of obesity and overweight was 36.3% (95% CI: 32.6, 40.1), 1.4% higher than the prevalence in 2012 (34.9%; 95% CI: 33.7, 36.2). The prevalence was higher in females (39.2%; 95% CI: 33.6, 44.9) than in males (33.5%; 95% CI: 28.9, 38.3), and in urban, compared to rural areas (36.7% vs. 35%). While, in 2012, the northern region showed the highest obesity prevalence among adolescents (16%), and in 2016 the highest prevalence of adolescent obesity shifted to Mexico City (19%), while obesity prevalence in the North remained stable over the four-year period (16%).

1.3.1 Determinants of obesity and overweight in Mexico

Obesity and overweight are complex and multifactorial problems (Finegood et al., 2010). This section presents a brief overview of the evidence available on the determinants of obesity and overweigh in the Mexican population.

1.3.1.1 Socio-demographic characteristics

Socio-economic status (SES) has been considered a determinant of overweight and obesity in developed and developing countries. Notwithstanding, it has been suggested that the role of SES on weight gain does depend on each country's respective levels of socioeconomic development and the stage of any nutrition transitions (Dinsa et al., 2012; Levasseur, 2015; Monteiro et al., 2004; Ullmann et al., 2011). That is to say, broadly speaking, that as the gross national product (GNP) increases, the prevalence of obesity will affect more acutely people with low SES, while in countries with lower GNP obesity will be more prevalent among people from higher SES (Monteiro et al., 2004). The findings from two systematic reviews of cross-sectional studies suggests that the relationship between SES and weight gain is shifting in developing countries and it can no longer be attributed only to individuals with high SES (Dinsa et al., 2012; Monteiro et al., 2004). However, according to Dinsa et al. (2012), this trend is stronger in middle-income, compared to low-income countries.

Recent longitudinal evidence from Mexico suggests that among adults residing in urban areas and among four distinct SES groups (poor class, lower-middle class, upper-middle class and upper class), coming from a lower-middle class background was associated with higher overweight and obesity over time (β= 51.8; $p<0.01$), as well as a higher waist-to-height ratio (β=1.46; $p<0.01$). This was followed by the upper class (β=33, $p<0.05$ and β=0.97, $p<0.01$ respectively) (Levasseur, 2015). Quezada et al. (2015) found that overweight and obesity in men increased concurrently with the wealth index between 2006 and 2012, whereas in women, overweight and obesity increased in the middle and upper-middle class but decreased for upper class women (inverted u shape or quadratic form).

A recent study examined the association between SES and weight gain among Mexican youths (Hernández-Cordero et al., 2017). The study used the Household Living Condition Index (HLCI) as an SES proxy. The overweight and obesity trends in relation to the HLCI between 1999 and 2012 indicated that school-aged children in the lowest, compared to the highest, HLCI quintile, experienced a higher increase in overweight and obesity. However, between 2006 and 2012 the prevalence of overweight and obesity among female adolescents increased at a higher rate in the lowest HLCI quintile (Q1=4.7±1.6 percentage points, p=0.003), rather than in the highest quintile (Q4= 3.8±1.8 percentage points, p=0.04).

The latest estimates indicate that the prevalence of obesity and overweight in school-aged children (5-10y) increased as the SES decrease (Hernández-Cordero et al., 2017). However, the prevalence of obesity in adolescents was higher in the highest, compared to the lowest quintile of HLCI (Hernández-Cordero et al., 2017). Hence, obesity and overweight in children and adolescents are still more prevalent among those with a high SES. More follow-up research is needed before concluding that the association between SES and weight gain is shifting in the Mexican population. Nonetheless, the evidence to date indicates that this association is actively changing, potentially fuelled by economic changes at national and household levels, supporting the notion that SES can determine the type and variety of food consumed (López-Olmedo et al., 2018b).

1.3.1.2 Physical activity and sedentary behaviours

Physical activity (PA) levels have decreased considerably while sedentary behaviour has increased worldwide (Gupta et al., 2012). These changes in activity patterns have been attributed mainly to urbanisation and the introduction of new technologies that have shifted the nature of many occupations, i.e. from manual labour to desk-based jobs (Gupta et al., 2012; Wang et al., 2018).

In Mexico, 83% of children (10-14 years), 39% of adolescents (15-19 years) and 14% of adults (20-69 years) do not meet the WHO guidelines that recommend 150 minutes of moderate-intensity physical activity per week (Hernández Ávila et al., 2016). Moreover, 77% of children (10-14 years), 79% of adolescents and 55% of adults spend more than two hours per day sitting in front of a screen (Hernández Ávila et al., 2016). A decrease in energy expenditure via low levels of PA and a high prevalence of sedentary behaviours has been associated with overweight and obesity in Mexico (Medina et al., 2017). Among the determinants of PA levels across the Mexican population are socio-demographic factors like age, gender, area of residence (urban/rural) (Ortiz-Hernandez and Ramos-Ibanez, 2017), urbanicity (Hermosillo-Gallardo et al., 2017), and the built environment (Jáuregui et al., 2016; Salvo et al., 2014). Although, the focus of this thesis is not on PA, interventions to promote and increase PA as well as the implementation of different policies to modify the built environment are needed among the Mexican population to reach the international recommendations of PA, and thus contribute significantly to preventing and reducing the prevalence of overweight and obesity.

1.3.1.3 The food environment

The food environment includes the availability and accessibility to food at home and out-of-home, such as in restaurants, supermarkets, convenience stores, vending machines, and takeaways (Lake and Townshend, 2006; Townshend and Lake, 2016). Among the suggested mechanisms through which the food environment could contribute to weight gain is the access and proximity to fast food outlets and small convenience stores, which are known to often provide easy-access to unhealthy food choices that increase daily caloric intake (Block et al., 2011; Smith et al., 2013).

Compared to the extensive evidence base investigating the food environments in developed countries (Cobb et al., 2016), the evidence from Mexico is scarce and recent. Only a few studies have focussed on the role of the food environment in obesity. Hernández-Barrera et al. (2016) examined the association between the food environment around elementary schools and children's BMI in two Mexican cities and found a positive association between the number of mobile food vendors (i.e. peddlers, pushcarts that locate themselves right outside the school gate at the beginning and end of the school hours) and children's BMI after adjusting for possible confounders ($\beta=0.066$; $p=0.004$). However, no association was found between the presence of other food establishments (i.e. restaurants, fast food outlets, cafes and temporary street vendors) and children's BMI. Another study examined the association between the density of food and beverage establishments and BMI in adults using the ENSANUT-2012 (Molina et al., 2017). The results indicated that the highest density of food and beverage establishment was associated with an increased BMI (by 0.50 kg/m^2; 95% CI:

0.33,0.67), whereas a higher density of fruit and vegetable shops were associated with a decreased BMI (by 0.24 kg/m^2; 95% CI: -0.37, -0.12) (Molina et al., 2017). Although research on food environments in Mexico is only recently emerging, the available evidence suggests that the food environment plays an important role in promoting weight gain in both adults and children, mainly through the availability and practicality of acquiring high-calorie food on public roads and schools.

1.3.1.4 The nutritional transition

Parallel to the epidemiological transition, Mexico has undergone a rapid nutritional transition. Nutritional transition refers to the change in the population weight status and diet quality characterised by a shift from undernutrition to obesity and diet related NCDs (Rivera et al., 2004). Changes in dietary patterns have been observed since the late 90s, where the traditional Mexican diet (based primarily on foods like corn, beans, fruits and vegetables) was substituted with industrially produced food with high fat, sodium and sugar contents (Beltrán-Sánchez and Crimmins, 2013; Rivera et al., 2004). These dietary changes have been fuelled by urbanisation, changes in the food industry and the introduction of global economic policies, such as the NAFTA (Gomez-Dantes et al., 2016).

1.3.1.5 Diet

According to the WHO, the fundamental cause of overweight and obesity is an energy imbalance between the quantity of calories consumed and calories expended (World Health Organisation, 2018a). Based on this definition, it has been estimated that subgroups of the Mexican population exceed their caloric intake requirements (estimated energy requirements or EER). For instance, the mean caloric intake for pre-schoolers, school-aged children, and female adolescents exceed the recommendations by 20%, 10% and 7% respectively, whereas male adolescents', men's and women's caloric intake was slightly below the energy requirements (EER: 95%, 90% and 99%) (López-Olmedo et al., 2016). The highest percentage of daily energy contribution comes from cereals (35%), followed by high saturated fat and/or added sugar products (16%), meat and animal products (14%) and SSBs (10%) (Aburto et al., 2016). However, fruit and vegetables and legumes were the lowest contributors to energy intake (5.7% and

3.8%, respectively) (Aburto et al., 2016). In addition, it was estimated that less than 25% of the Mexican population adhered to dietary recommendations for fruit and vegetables, legumes, seafood, dairy, SSBs and products high in saturated fat and sugar (Batis et al., 2016a).

Research looking at dietary patterns and their association with overweight and obesity in Mexican school children suggests that patterns like the “sweet cereals and corn dishes” pattern (characterised by a high intake of sweet cereals, corn dishes with fat, sweets and dairy products) and the “western” pattern (characterised by a high intake of soft drinks, cakes, fried food and salty snacks), compared to the “rural” pattern (legumes and corn tortilla), were associated with childhood overweight and obesity [PR (prevalence ratios)=1.29; 95% CI: 1.09, 1.94 and PR=1.35, 95% CI: 1.17, 2.19, respectively] (Rodriguez-Ramirez et al., 2011).

In adolescents, those in the highest tertile of the “westernised” (characterised by high intake of refined cereals, snacks, desserts, sweets and sugar, pastries, soda) and “high in protein/fat” pattern (characterised by a high intake of eggs, poultry, red meats, sausages and alcohol) showed a higher BMI (26.2 ±3.9 kg/m^2 and 25.5 ±3.8 kg/m^2) than adolescents in the highest tertile of the “prudent” pattern (characterised by high intake of vegetables, legumes, nuts and seeds, fruits and whole grains) (21.8 ±3.4 kg/m^2) (Gutiérrez-Pliego et al., 2016).

In adults, dietary patterns like the “refined food and sweets” pattern (characterised by a high intake of alcohol, soft drinks, white bread, fast food, sweets and salty snacks) and the “diverse” pattern (characterised by a high intake of whole-fat dairy, rice, pasta, meat and poultry, eggs, saturated fats, fruit and vegetables), compared to the “traditional” pattern (characterised by a high intake of maize foods and legumes) were more likely to be overweight or obese (OR = 1.14; 95% CI: 1.02, 1.26 and OR = 1.17, 95% CI: 1.03, 1.33, respectively) (Flores et al., 2010). In addition to this, it was observed that adults following a “refined food and sweets” pattern had a higher energy intake (8340±3584 kJ) but lower mean physical activity (0.98±2.0 h/week) compared with those who follow the traditional pattern (7591±3366 kJ1.23±2.3of PA h/week) (Flores et al., 2010), which may be contributing to the energy imbalance and therefore excessive weight gain.

Overall, the diet of the Mexican population has deteriorated and is characterised by excess caloric intake (mostly among young people), low adherence to recommendations of foods that help maintain optimal health (fruits vegetables, legumes, corn tortilla, low-fat dairy products) and excessive amounts of added sugars and saturated fat. Across the evidence base on energy intake and dietary patterns, it was possible to observe the contribution of discretionary foods (SSBs and foods high in sugar and saturated fat) to the diets of the Mexican population. In this vein, Aburto et al. (2016) suggested that discretionary foods account for 26% of the daily energy intake among adults and around 30% for school-aged children and adolescents. These discretionary foods are also considered the main contributors to inadequate dietary patterns, thereby contributing to obesity and NCD prevalence (López-Olmedo et al., 2016).

1.4 Sugar-sweetened beverages

SSB intake has been linked with weight gain and NCDs like diabetes, hypertension, cancer, dyslipidaemias and dental caries, mainly due to their respective high contents of added sugars (Te Morenga et al., 2013). Sugars in food can be intrinsic (those incorporated in the structure of fruits and vegetables), sugars from milk (those naturally found in milk like lactose and galactose), free sugars, defined by the WHO as “monosaccharides and disaccharides added to foods and beverages by the manufacturer or consumer, and those sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates” (World Health Organisation, 2015), and added sugars, which, according to the US Department of Agriculture (USDA), are “all monosaccharides and disaccharides (including refined sugars from cane, beet, and corn honey, invert sugar, lactose, malt syrup, maltose, molasses, raw sugar, sucrose, trehalose, and turbinado sugar) added to foods by the manufacturer, the cook, or the consumer” (Bowman, 2017; Hess et al., 2012). Although the terms ‘free sugars’ and ‘added sugars’ are very similar and are sometimes (incorrectly) used interchangeably in the literature, their main difference is that free sugars include sugar naturally present in 100% fruit juices and fruit juice concentrates (Erickson and Slavin, 2015).

Added sugars provide insignificant amounts of micronutrients or other essential nutrients to the diet whilst they increase dietary total energy (Hess et al., 2012). A recent study analysed the intake of added sugars in 10,096 Mexicans using data from the ENSANUT-2012 and showed that the average caloric intake from added sugars was 238 kcal/day, which represented 12.5 % of the daily energy intake, thereby exceeding the WHO recommendations for free sugars <10% of total energy intake. SSBs were found to be the main source of added sugars in the diet of the Mexican population providing 10% of total energy intake (Sánchez-Pimienta et al., 2016)

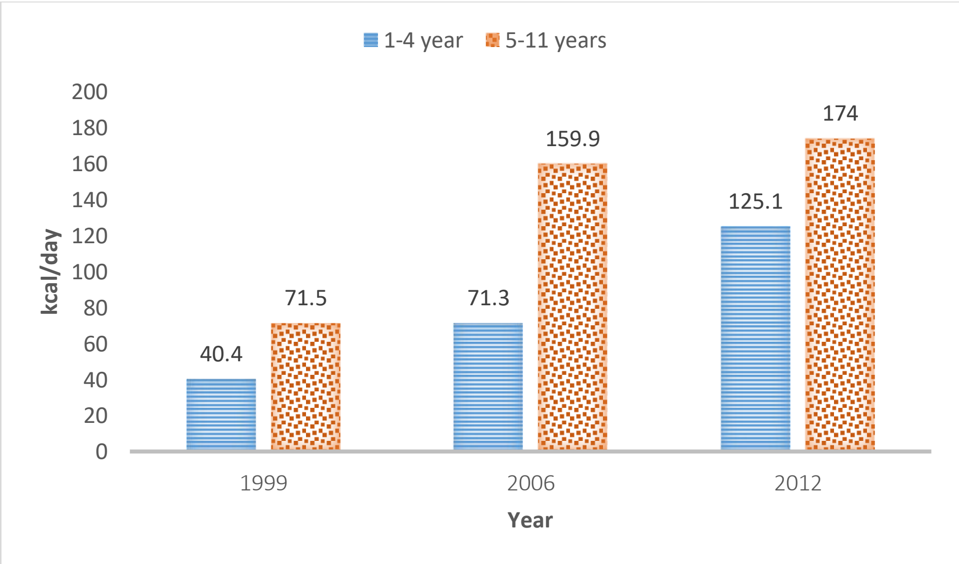
SSBs are a group of beverages that contain added sugars in the form of sucrose (table sugar) or high-fructose corn syrup (HFCS) (Ebbeling, 2014). The SSB spectrum includes non-alcoholic carbonated and non-carbonated beverages such as sodas/soft drinks, fruit juices, fruit flavoured beverages and sweetened iced teas. As no standard classification exists for SSBs, definitions vary significantly across the literature. Some authors also include sport drinks and energy drinks (Ranjit et al., 2010; Tak et al., 2011), sweetened coffee/tea (Ebbeling, 2014), energy drinks (Park et al., 2014; Perkins et al., 2010) and flavoured milk (Avery et al., 2014; Mazarello Paes et al., 2015). Moreover, Singh et al. (2015) defined SSBs as beverages containing over 50 kcal per 8oz serving. However, some other studies investigating energy drinks (EDs) separate them from other sugar containing beverages due to the their high content of caffeine (Francis et al., 2017; Visram et al., 2017).

For the purpose of this thesis, SSBs include non-alcoholic and non-dairy beverages with added sugars such as soda, sweetened juices, iced teas, fruit flavoured beverages, sweetened coffee and tea, sports and energy drinks. With this in mind, considering this research is country-specific, it is important to take into account the traditional SSBs that are widely consumed in Mexico, such as *aguas frescas* or sweetened waters, defined as a blend of water, fresh fruit, cereals, flowers or seeds and added sugar. *Aguas frescas* are mainly prepared at home but can also be purchased at restaurants, markets and from street vendors. *Atole* is another traditional Mexican hot beverage prepared with water or milk, corn flour, fruits, spices and "*piloncillo*" (unrefined cane sugar). Both *aguas frescas* and *atole* were included within the definition of SSBs for this thesis. Sweetened dairy beverages were excluded from the definition of SSB because they contain both naturally occurring sugars and added sugars, and they are a source of macro- and micronutrients (Singh et al., 2015).

1.4.1 SSB intake in the Mexican population

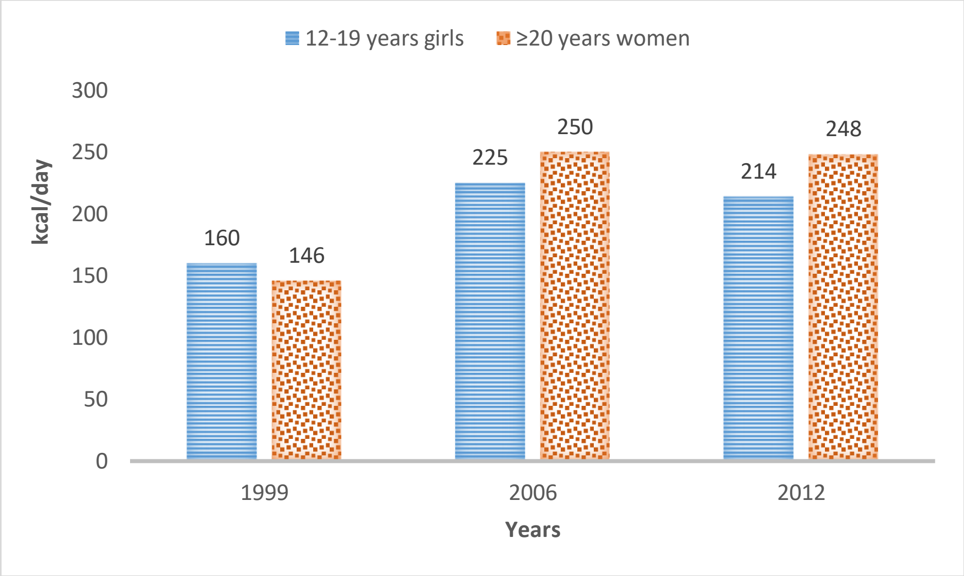
The examination of SSB intake trends in Mexico has shown an increasing trend in energy intake and in millilitres from SSBs per capita. As shown in Figure 1.2 and Figure 1.3 the energy intake from SSBs doubled between 1999 and 2006 across the Mexican population (Barquera et al., 2008). Between 1999-2012, an increase in regular soda, *aguas frescas* and sweetened vegetable and fruit juices was observed in children, female adolescents and women (intake data for male adolescents and men was available until 2006) (Stern et al., 2014).

Figure 1.2 Energy intake trends from sugar-sweetened beverages in children (1-11 years) between 1999 and 2012



Adapted from Barquera et al. (2010) and Stern et al. (2014)

Figure 1.3 Energy intake trends from sugar-sweetened beverages in female adolescents and women between 1999 and 2012



Adapted from Barquera et al. (2008) and Stern et al. (2014)

According to the ENSANUT-2012, the average intake of SSBs in the Mexican population was 436.3 ml/day (Stern et al., 2014). It was observed that the mean per capita intake of SSBs increased with age. For instance, preschool children (1-4 years) consumed an average of 248ml/day while school-aged children (5-11years) had double this intake (407 ml/day). The mean intake per capita was even higher in adolescents (12-18 years), with 542.6 ml/day, and this intake was similar in adults aged 20-59 years (547.6 ml/day) (Stern et al., 2014). Based on results from the same survey, SSBs alone contributed 9.8% of the total energy intake of the Mexican population (Aburto et al., 2016). School-aged children showed the lower percentage of energy contribution from SSBs (7%), compared to adolescents (9.5%) and adults (10.6%) (Aburto et al., 2016). The types of SSBs that contributed more to the total energy intake in all age groups were regular soda (188 kcal/day) and *aguas frescas* (146 kcal/day) (Sánchez-Pimienta et al., 2016)

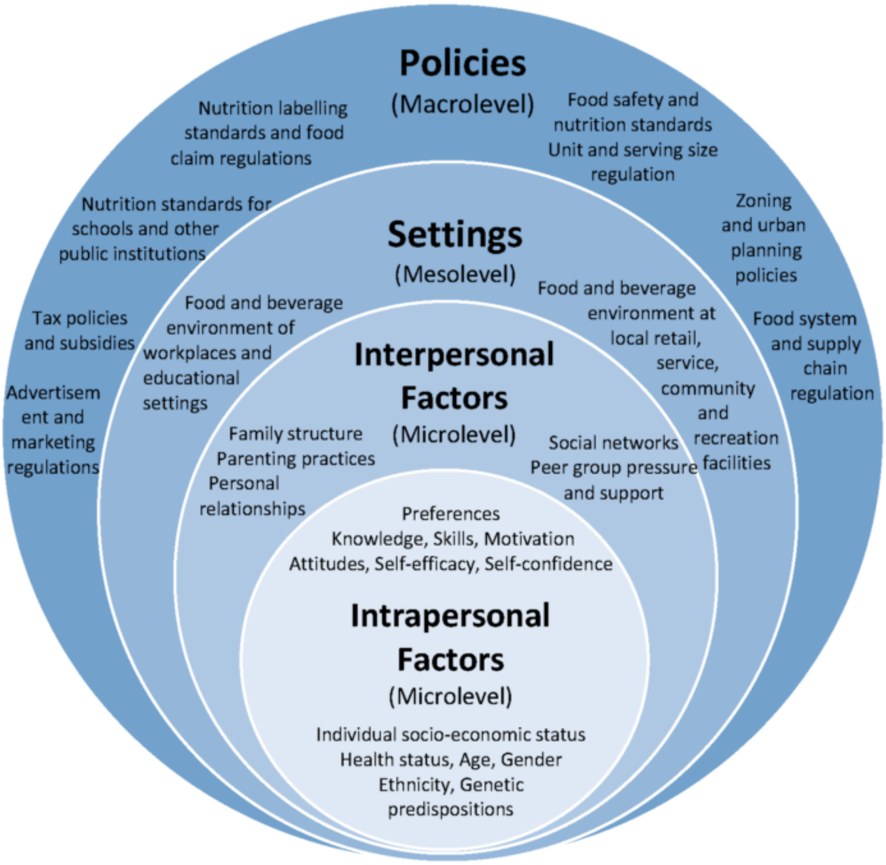
Overall, the intake of SSBs in Mexico is high and it has clearly contributed to an excessive energy intake derived from added sugars. Compared to the intake of SSBs in developed countries, Mexican adults consume more servings of SSBs daily (2.61 servings vs. 2.17 servings in US adults vs. 1.05 servings in adults in the UK and 0.96 servings in the Netherlands) (Singh et al., 2015).

Although there is evidence to support the high intake of SSBs in Mexico, research is scarce around the factors associated with SSB intake. Research conducted in developed countries has suggested that there are several behavioural, social, and environmental factors associated with SSB intake (see Chapter 2). Nonetheless it is unknown the extent to which these factors are equally applicable to the context of developing countries, particularly countries with substantially higher SSB intake and obesity rates, and where social, cultural and economic contexts diverge significantly from those in developed countries.

1.5 Theoretical underpinning

It is important to recognise that although a great deal of research has concentrated mainly on food policies, the intake of SSBs is also contingent upon a diverse range of contextual factors. SSB intake is a complex problem that encompasses many fields and therefore is it important to acknowledge which individual, social and environmental domains are associated with SSB consumption in Mexico. Therefore, the work presented in this thesis is underpinned by a socio-ecological model. The socio-ecological model is a framework that suggests that multiple levels of influence affect health behaviour (Mcleroy et al., 1988; Philipsborn et al., 2016; Story et al., 2002). There are four levels of influence: 1) individual or intrapersonal factors ; 2) social or interpersonal factors, and environmental factors that are divided in 3) settings or meso-level; and 4) policies or macrolevel (Peeters, 2018; Philipsborn et al., 2016) (Figure 1.4).

Figure 1.4 Socio-ecological model of food and beverage intake. From Philipsborn et al.,2016.



The framework proposes that there is an interaction among different factors across these four levels and within each level of influence (Philipsborn et al., 2016; World Health Organisation, 2018b). The socio-ecological model can incorporate multiple theories or constructs from different intrapersonal, interpersonal and organisational theoretical models along with environmental and policies concepts (Glanz et al., 2008). Finally, the socio-ecological model can be applied to the development comprehensive intervention that targets the mechanism of changes at each level of influence (Glanz et al., 2008)

1.6 Thesis aim and specific objectives

The overarching aim of this thesis is to investigate the individual, social, meso and macro level factors that promote the intake of SSBs in the Mexican population, focussing mainly upon the segment of the population with the highest SSB intake.

The specific objectives are:

1. To identify the socio-demographic profile of the different types of SSB consumers using a representative sample of the Mexican population (Chapter 3).
2. To assess the association among individual, social and meso level factors and the intake of SSBs in a sample of Mexican adolescents (Chapter 4).
3. To assess if individual level theories (theory of planned behaviour and habit theory) are useful to explain the intake of SSB in a sample of Mexican adolescents (Chapter 4).
4. To explore the perceptions of a sample of adolescents on how home and out-of-home environments contribute to the SSB intake in a sample of Mexican adolescents (Chapter 6 and 7).
5. To explore adolescents' awareness and perceptions of the SSB tax in a sample of Mexican adolescents (Chapter 8).

1.7 Structure of the thesis

Chapter 2 presents an overview of the theories used to understand SSB intake. It outlines some of the literature on the factors associated with SSB intake in Mexico and around the world and it describes the policies implemented in Mexico to reduce the intake of SSBs. Chapter 3 presents a secondary analysis of the Mexican Health and Nutrition Survey 2012 and examines the socio-demographic profiles of SSB consumers in Mexico. Chapter 4 is based on the results presented in Chapter 3 and examines the association between the intake of SSBs and different individual, social and environmental factors in a sample of Mexican adolescents (a population group with the highest intake). Adolescence in this thesis is defined as the transitional period between the childhood and adulthood between the age of 12 and 19 year [2]. Chapter 4 also examines if the theory of planned behaviour and habit theory help to explain the intake of SSB. Chapter 5 describe the methods used to collect and analyse interviews of a sample of

[2] It is important to note that the age range of adolescence vary across the literature. For instance the WHO considers adolescence between the age 10 and 19 which overlaps with the concept of youth (15-24 years) and young people (10-24 years)(World Health Organisation, 2014b).

Mexican adolescents. It includes information about the participants, data collection, the development of the interview guides and the data analysis process. Chapters 6 and 7 present the findings of an exploration of SSB intake in different settings where adolescents grow up. Chapter 6 explores adolescents' perceptions of the role of the home environment, including the family context, and the availability and intake of SSBs. Chapter 7 explores adolescents' perceptions of the role of out-of-home environment, encompassing school and wider social activities. Chapter 8 explores adolescents' awareness and perceptions of the SSB tax. The chapter particularly explores how the tax has affected adolescents' purchasing habits and by extension their intake of SSBs. Finally, Chapter 9 presents an overall discussion of the thesis findings, their wider implications for theory, interventions, policy and research, together with the strengths and limitations of the work and an overall conclusion.

Chapter 2 Literature Review

The aim of this chapter is to review the existing literature related to SSB intake and to establish how the research questions of this thesis build upon the current evidence. Firstly, a broad overview of the health risks of consuming SSBs is proffered. Secondly, the theoretical models used to explain intake of SSBs are set out. Thirdly, a detailed analysis of the individual, social, meso-level and macro-level factors associated with SSB intake is offered. Fourthly, for context there is an outline of current policies implemented in Mexico that aim to reduce intake of SSBs. Finally, the chapter present a global discussion of the literature with emphasis on how the evidence relates to the objectives and research questions of this thesis.

Relevant literature was identified by searching combination of words and terms in several bibliographic databases (PubMed, ENBASE, PsycINFO, SciELO), Google Scholar and Mendeley. Additionally, a manual search was conducted in several article reference lists and on the websites of key organisations in the area of public health nutrition (i.e. the WHO website, the Mexican Institute of Public Health, the U.S. Centers for Disease Control and Prevention)

2.1 Overview of sugar-sweetened beverages intake and health risks

High intake of SSBs has been linked with several negative health outcomes before and during adulthood (Ambrosini et al., 2013). The following sections briefly review the literature about the relationship between health issues and SSB intake.

2.1.1 Overweight, obesity and sugar-sweetened beverages

SSB consumption has been associated with obesity and overweight in many countries (Bucher Della Torre et al., 2016; Luger et al., 2017; Malik et al., 2013). The relationship between the intake of SSBs and obesity has been widely studied giving rise to a debate over the years largely rooted in conflicts of interest. Worthy of specific mention in this regard is the question of whether funding from the industry has directly influenced the results (Bes-Rastrollo et al., 2013). However, current evidence from systematic reviews and meta-analyses (of studies not funded by the industry) has consistently demonstrated that the intake of SSBs is associated with overweight and obesity in children and adults (Keller and Bucher Della Torre, 2015; Luger et al., 2017; Malik et al., 2013; Vartanian et al., 2007).

Two physiological mechanisms have been suggested to explain the association between the intake of SSBs and weight gain. The first one proposes that individuals do not self-regulate energy from liquid carbohydrates (SSBs) in the same way as the energy obtained from solid foods (Dimeglio and Mattes, 2000; Woodward-Lopez et al., 2011). One reason for this is that liquid carbohydrates are rapidly consumed and absorbed by the gastrointestinal tract, thus generate less satiety. Therefore, individuals appear to have an incomplete compensatory reduction in their overall energy intake and therefore consume other types of foods following the intake of liquid calories increasing their daily energy intake (Dimeglio and Mattes, 2000; Hu and Malik, 2010; Woodward-Lopez et al., 2011). The second proposed mechanism is that fructose (constituent of both sucrose and HFCS) is metabolised to lipids in the liver, leading to increased hepatic denovo-lipogenesis through the synthesis of hepatic triglycerides. This overproduction contributes to an increase in adipose tissue and the subsequent ectopic accumulation of lipids (lipotoxicity) (Silva and Durán, 2014). This process can also lead to insulin resistance (Stanhope et al., 2009).

A comprehensive systematic review and meta-analysis conducted by Malik et al. (2013) reviewed 15 cohort studies and 5 randomized control trials (RCT) among children and adolescents, and 7 cohorts and 5 trials in adults conducted up to March 2013. Pooled estimates from cohort studies in children suggest that for each one 12-oz serving of SSBs, there was an increase of 0.07 kg/m^2 in BMI (95% CI: 0.01 to 0.12). Results from the RCTs suggested that a reduction of SSBs results in a decrease in BMI by 0.12 kg/m^2 (95% CI: -0.22 to -0.02). In adults, pooled estimates of cohort studies suggest that each serving per day of SSBs (12-oz serving) was associated with a 0.22 kg (95% CI: 0.09 to 0.34) weight gain over a 1-year period (random-effects model) and 0.12 kg (95% CI: 0.10 to 0.14) in the fixed effects model. In children and adolescents, pooled estimates from cohort studies suggested that each one 12-oz serving /day of SSB was associated with an increased BMI by 0.07 kg/m^2 (95% CI: 0.01, 0.12) in the random effects model, while in the fixed effects model the increase in BMI was 0.16 kg/m^2 (95% CI:0.15, 0.16). Evidence from RCTs in adults suggests that SSBs result in an increase in body weight by 0.85 kg (95% CI: 0.50 to 1.20) (Malik et al., 2013). A more recent systematic review of prospective studies and trials conducted between 2013 and 2015 found a positive association between SSB intake and weight gain in 96% of the prospective studies reviewed in children and adults (26 studies). Results from RCTs among children (n=3) suggested intake of SSBs had an impact on BMI overtime (Luger et al., 2017).

2.1.1.1 Overweight, obesity and sugar-sweetened beverages in Mexico

Relative to other countries, evidence from Mexico investigating the association between SSB intake and weight gain is scarce (Table 2.1). In adults, only one RCT and one prospective study were found. Hernandez-Cordero et al. (2014) conducted an RCT aimed to reduce plasma triglycerides (TGs), weight and other cardiometabolic factors. Both the intervention and control groups received the same educational information in the form of nutritional and psychological counselling. Apart from the education, the intervention group was provided with water (2-3 litres/day). By the end of the intervention (9 months), women in both groups lost weight, however there was no difference between the two groups (mean weight loss was -1.2 kg in the intervention group and -0.8kg in the control group, $p = 0.40$). The authors suggested that a possible explanation for the lack of difference on weight change between the two groups was the insufficient replacement of SSBs in the intervention group (Hernandez-Cordero et al., 2014). Moreover, a two-year prospective study among women found that changes in intake of caloric soda were associated with changes in weight. For instance, those women who increased intake by one serving (not defined in terms of ml) of caloric soda a week gained an average of 0.3 kg (95% CI: 0.2 to 0.5) compared to women who did not change their intake. In contrast, women who decreased intake of caloric soda by 1 serving/week gained 0.4 kg less (95% CI: –0.6,–0.2) than women who did not change their intake (Stern et al., 2017).

Table 2.1 Summary of studies looking at SSB intake and weigh gain in Mexican population

Study	N	Population	Age (year)	Design	Diet	Exposure	Outcome	Covariates	Findings
Hernandez-Cordero et al (2013)	485	Overweight and obese women who consumed ≥250 kcal/d of SSBs	18 to <45	RCT (9 months)	24HR (2 times)	**Intervention groups:** Water and education provision (WEP). **Control group:** Education provision (EP)	Changes in weight	Baseline characteristics	Weight loss was 1.2 kg in the WEP group and 0.8kg in the EP group ($p = 0.40$)
Stern et al. (2017)	11,218	Women	mean age 43y	Prospective (2 years)	SFFQ	Changes in intake of caloric soda over 2-year period	Weight Waist circumference	Smoking status, alcohol use, PA, Oral contraceptive use, Post-menopausal status, Hormone therapy use, recent physician-diagnosed disease.	Women who ↓ their soda intake (<-1 serving/week) gained ↓ weight (-0.4 kg; 95% CI=-0.6, -0.2). Women who ↑ soda (>+1 servings/week) ↑ an average of 0.3 kg (95% CI=0.2, 0.5). ↑ soda in 1 serving per day was associated with ↑ weight of 1.0 kg (95%CI=0.7, 1.2)
Children and adolescents									
Cantoral et al. (2015)	227	Children	12 months to 8 and 14 years	Prospective (14 years)	FFQ	Age of introduction to SSB Cumulative consumption of SSBs	Risk of general and abdominal obesity	SES Age Non-SSB energy intake PA TV watching	Early introduction to SSB (≤12 months) ↑ obesity (OR= 2.00, 95% CI: 0.87, 4.59). Children in the highest tertile of cumulative SSB intake, compared with the lowest, ↑ the odds of general (OR= 2.99, 95% CI: 1.27, 7.00) and abdominal (OR = 2.70, 95% CI: 1.03, 7.03) obesity at age 8–14 years.
Carvali-Meza et al. (2016)	1344	Adolescents	15 to 19	Prospective (2013-2014)	BEVQ -19	Intake of SSBs	Overweight and obesity Abdominal obesity	N/A	Those who did not reduce SSB in 12 months had ↑ risk of ↑ BMI (RR =1.71, p= 0.03)

Denova-Guitierrez et al. (2008)	1055	Adolescents	10 to 19	Cross-sectional	SFFQ	Intake of SSBs	BMI	Sociodemographic conditions, sexual maturation, dietary patterns and PA	↑ intake of SSBs ↑ BMI by 0.33 kg/m2 (p<0.001)
Jimenez-Aguilar et al. (2009)	10,689	Adolescents	10 to 19	Cross-sectional	SFFQ	Intake of SSBs	BMI	Non-beverage energy, Diet drinks, urban or rural. Age, SES, TV watching, Presence of menarche	↑ intake of soda ↑ BMI in male adolescents (β=0.17; p=0.03)
Gutierrez-Ruvalcaba et al. (2009)	210	Adolescents	12 to 16	Cross-sectional	FFQ and 24HR	Intake of SSBs	BMI Skin folds % body fat	N/A	↑ intake of SSBs (>750ml/day) ↑ the risk of being overweight or obese by 2.73 (95% CI: 1.27 to 5.86)

CI: Confidence intervals; PA: Physical activity; SES: Socio-economic status; OR: Odd ratios; BMI: Body Mass Index; RCT: Randomized control trial; RR: relative risk; SFFQ: Semiquantitative food frequency questionnaire; FFQ: Food frequency questionnaire; 24HR: 24 hours diet recall

Unlike evidence from adults, more literature has investigated the link between SSB intake and weight gain in Mexican youth, including three cross-sectional studies in adolescents and one prospective study among children (Table 2.1). Using data from the Early Life Exposure in Mexico to Environmental Toxicants (ELEMENT) project, Cantoral et al. (2015) examined the association between cumulative SSB intake in children over a period of 8 to 14 years and risk of obesity. The findings suggested that children in the highest tertile of cumulative SSB intake, compared to the lowest tertile, had almost three times the odds of general and abdominal obesity at age 8 and 14 years (OR=2.99, 95% CI: 1.27 to 7.00 and OR = 2.70, 95% CI: 1.03 to 7.03, respectively) (Cantoral et al., 2015).

Among adolescents, evidence looking at the association between intake of SSBs and weight gain comes mainly from cross-sectional studies. One study concluded that intake of each additional serving of SSBs was associated with a 0.33 unit increase in BMI ($p<0.001$) (Denova-Gutiérrez et al., 2008). Furthermore, a small study conducted in a secondary school in South West Mexico among adolescents aged 12-16 years concluded that high intake of SSBs (>750 ml/day) increased the risk of being overweight or obese by 2.73 (95% CI: 1.27 to 5.86) (Gutiérrez-Ruvalcaba et al., 2009). Jimenez-Aguilar et al. (2009) found that higher intake of sodas was positively associated with higher BMI only in male adolescents (β=0.17; 95%CI=0.02,0.32; p=0.03).

Compared to evidence suggesting an association between SSB intake and body weight in other countries, evidence from Mexico is limited. Nonetheless, all studies suggest a positive association between the intake of SSBs and weigh gain or changes in BMI. However, no research has yet examined the association between SSB and weight gain in men, and only one study has been conducted among children. It could be that the size of the association for these populations is different especially for males, who are known to consume higher amount of SSBs than women (Aburto et al., 2016; Barquera et al., 2010a, 2008) (see section 2.3.1.1).

2.1.2 SSB intake and cardiometabolic risk

Several studies in adults and adolescents have suggested the association between intake of SSBs and different cardiometabolic risk factors, such as high systolic blood pressure (Nguyen et al., 2009), hypertriacylglycerolaemia (Ambrosini et al., 2013; Barrio-Lopez et al., 2013; Chan et al., 2014; Duffey et al., 2010), and low levels of high-density lipoprotein cholesterol (HDL-C) (Ambrosini et al., 2013; Bremer et al., 2010).

SSB intake has been associated with the metabolic syndrome (MetS) (Barrio-Lopez et al., 2013; Chan et al., 2014; Malik et al., 2010b), a clustering of three or more cardiometabolic risk factors including abdominal obesity, blood pressure, high fasting plasma glucose, high serum triglycerides and low levels of HDL-C, and is associated with increased risk of cardiovascular disease and type 2 diabetes (Chan et al., 2014). In Mexico, only one cross-sectional study among Mexican adults has investigated the role of SSBs in MetS incidence, suggesting that SSB intake is directly associated with MetS; adults who consumed >2 servings/day of SSBs had 2.0 times greater risk to develop MetS (95% CI:1.1,3.1) than those who did not consume SSBs (Denova-Gutiérrez et al., 2010).

2.1.3 Hyperuricemia

According to the literature, the intake of SSBs is associated with an increase in serum uric acid (SUA) levels or hyperuricemia, which is also known for inducing features of the metabolic syndrome, cardiovascular risk factors (Nguyen et al., 2009) and chronic renal disease (Lin et al., 2013). Fructose is the only simple carbohydrate known to increase serum uric levels by inducing uric acid production and increasing adenosine triphosphate degradation to adenosine monophosphate, a uric acid precursor (Hu and Malik, 2010). Studies conducted among adults (Choi et al., 2008) and adolescents (Lin et al., 2013; Nguyen et al., 2009) have suggested a positive association. In Mexico, a cross-sectional study conducted among low income Mexican adults found that high intake of SSBs (>1 bottle/day) was associated with higher SUA levels (P<0.001) (Lopez-Molina et al., 2013). Similarly, men and women who consumed <3 servings of SSB/day (240 ml per serving), had increased SUA levels by 0.38 mg/dl and 0.21 mg/dl, respectively; their odds of presenting with hyperuricemia was 2.29 (95% CI=1.55 to 3.38) in men and 1.35 (95% CI=1.04 to 1.75) in women (Meneses-Leon et al., 2014).

2.1.4 Insulin resistance and Type 2 diabetes

Two pathways have been suggested via which SSB intake could promote incidence of type 2 diabetes: 1) high SSB intake increases dietary glycaemic load, which could cause insulin resistance, impaired β cell function and inflammation (Ambrosini et al., 2013); and 2) high intake of SSBs contributes to an excessive energy intake, increasing the risk of weight gain, which is a key risk factor for type 2 diabetes (Greenwood et al., 2014). Four systematic reviews and meta-analyses of longitudinal studies among adults demonstrated a positive association between intake of SSBs and type 2 diabetes, even after the adjustment for energy intake (Malik et al., 2010a), BMI (M. Wang et al., 2015) and adiposity (Greenwood et al., 2014; Imamura et al., 2015; Malik et al., 2010a). Only one study has examined the role of SSB intake and insulin resistance, a risk factor for type 2 diabetes, in adolescents, suggesting a positive association (Bremer et al., 2010). No evidence from Mexico has supported the relationship between SSB intake and insulin resistance or type 2 diabetes.

2.1.5 Cancer

Intake of SSBs has also been associated with the prevalence of obesity-related cancers (Hodge et al., 2018). Although it has been proposed that this association might be moderated by obesity, there is also evidence suggesting that soft drinks, predominantly colas, contain 4-methylimidazole, a caramel colouring agent, which has been assessed as a carcinogenic in humans (Hodge et al., 2018). To date, no study has been conducted in Mexico that investigates any potential association between SSB intake and cancer.

2.1.6 Dental caries and erosive tooth wear

Dental caries are defined as an infectious disease characterised by the fermentation of carbohydrates by oral bacteria, causing demineralisation of the tooth surface (Marshall, 2013). Intake of sugar is considered one of the major dietary factors for the development of dental caries (Moynihan and Kelly, 2014), which is why SSB intake is considered as a risk factor for dental caries (Armfield et al., 2013; Bernabé et al., 2014; Wilder et al., 2016). Although intake of SSBs and prevalence of dental caries in Mexico is high (48% to 95% in children and 53.4% in adolescents) (García-Cortés et al., 2009), no evidence is available to support the association between SSBs and dental caries .

Another dental health risk associated with SSB intake is erosive tooth wear. Erosive tooth wear is defined as the dissolution of dental hard tissue due to high acidity. Owing to their content of phosphoric acid and citric acid, carbonated beverages and sport drinks are considered among the major contributors to erosive tooth wear (Armfield et al., 2013; Lussi and Carvalho, 2015). A small cross-sectional study conducted among Mexican adolescents (13 to 19 years) showed that those who reported a high intake of sweetened carbonated drinks had 80% higher odds of having erosive tooth wear than those who did not consume carbonated drinks (OR= 1.80, 95% CI= 1.06 to 3.07) (González-Aragón Pineda et al., 2016).

In summary, a high SSB intake has several demonstrable detrimental implications for health. Therefore, it is important to direct efforts to promoting the reduction of SSBs among those groups in the population with the highest intake of SSB in order to prevent and reduce NCDs, their risks factors and also oral health issues.

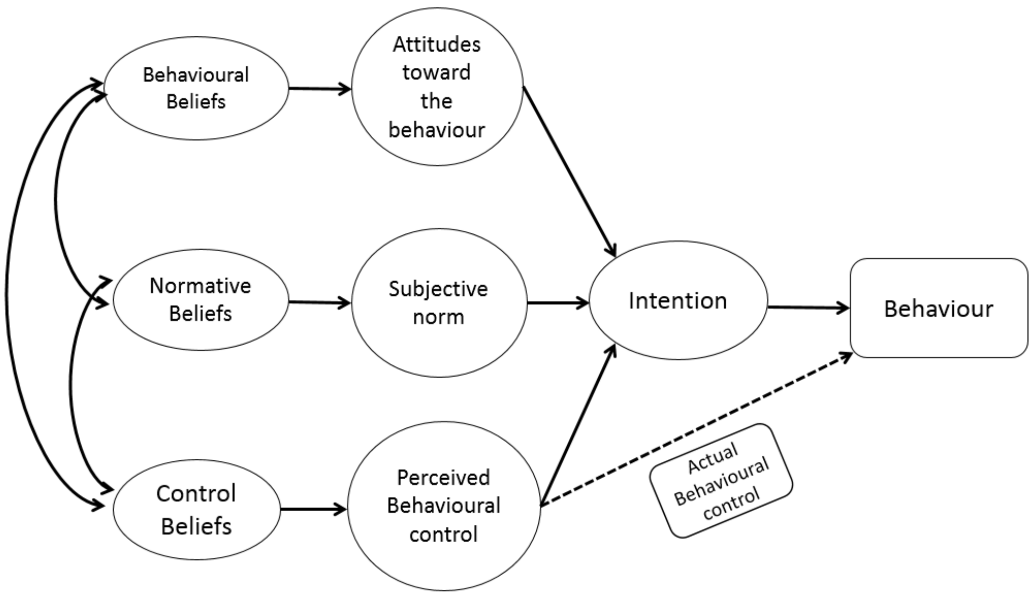
2.2 Understanding of SSB intake from theory

Theoretical models can help to explain behaviours, by describing the factors that guide people’s behaviours (Glanz and Rimer, 2005; Rothman, 2004). There are various theoretical models that have been used to investigate the determinants of diet in children and adults. These theories typically focus on different levels of influence such as micro-level (intrapersonal and interpersonal factors) and meso-level (settings) (Glanz and Rimer, 2005). Based on the extent to which theories have been used to explain the intake of SSBs in previous literature, four theoretical models are discussed below.

2.2.1 *Theory of planned behaviour (TPB)*

Among the most used theories to understand dietary behaviours is the TPB. According to the TPB, human behaviour is guided by three types of beliefs: 1) behavioural beliefs (beliefs and evaluation about the outcomes of the behaviour); 2) normative beliefs (beliefs about the social expectations and the motivation to comply with these expectations); and 3) control beliefs (beliefs about the presence of factors that may facilitate or impede performance of the behaviour) (Ajzen, 2006). As shown in **Figure 2.1**, these beliefs produce specific *attitudes* toward performing the behaviour (the degree to which the person has a favourable or unfavourable evaluation of the behaviour), *subjective norms* (beliefs about whether other people who are important approve or disapprove of the behaviour) and *perceived behavioural control* (people's belief that they can or cannot control a particular behaviour) (Ajzen and Driver, 1991; Glanz and Rimer, 2005). In conjunction with each other, attitudes, subjective norms, and perceived behavioural control (PBC) lead to the formation of a behavioural intention, which, according to the theory, is the most important determinant of behaviour (Ajzen, 1988). Moreover, Ajzen and Madden (1986) proposed a direct link between PBC and behaviour (broken line in **Figure 2.1**), as PBC can serve as a proxy for actual control (volition or will) (Ajzen, 2002; Ajzen and Madden, 1986).

Figure 2.1 The Theory of Planned Behaviour. Adapted from Ajzen, 2006



The evidence has supported the usefulness of TPB as a predictor of intention to perform different health behaviours (Armitage and Conner, 2001; Godin and Kok, 1996). In the context of SSB intake, the TPB has been one of the most used theories to explain SSB intake. A total of 13 studies have used the TPB, where nearly all studies were conducted in the US and in the Netherlands among children, adolescents and adults (Table 2.2 and Table 2.3). Overall, TPB explained around 37% (range 28-48%) of the intake of SSBs. This indicates that as an individual level theory, the rest of the variance could be explained by other social and environmental factors.

Table 2.2 Summary of studies that have used the TPB to explain intake of SSBs

Study	N	Country	Population	Design	Diet	Exposure	Outcome	Covariates	Findings
Kassem & Lee (2003)	707	U.S.	Female adolescents 13-18y	Cross-sectional and interviews	FFQ	Behavioural intentions Attitude Subjective norm PBC	Regular soda intake	N/A	Attitude (β=0.58, p=<0.0001), subjective norm (β=0.14; p=<0.0001) and PBC (β=0.24; p=<0.0001;) were associated intention to drink soda, predicting 64% of it variance. Intention was associated with soda intake (β=0.5; p=<0.0001) and explained 28% of the variance of soda intake.
Kassem & Lee (2003)	564	U.S.	Male adolescents 13-18y	Cross-sectional and interviews	FFQ	Behavioural intentions Attitude Subjective norm PBC	Regular soda intake	N/A	Attitude (β=0.52; p=<0.0001), subjective norm (β=0.19; p=<0.0001) and PBC (β=0.28; p=<0.0001) were associated with soda intake and explain 61% of it variance. Intention associated soda intake (β=0.38; p=<0.0001) and explained 38% the variance of SSB intake
de Bruijn et al. (2007)	208	Netherlands	Adolescents 12-18y	Cross-sectional	FFQ	Intention to reduce SSBs, attitudes, PBC for limiting SSB, Parent and peer subjective norm	Soda intake	Age and gender	Attitude (β= 0.32, P < 0.001), subjective norm (b =0.22, p= 0.001) and PBC (β = 0.16, p = 0.015) were associated with intention. Intention was associated with SSBs (β=-0.20; p=0.003). The final model explained 14% of variance in adolescent soft drink consumption

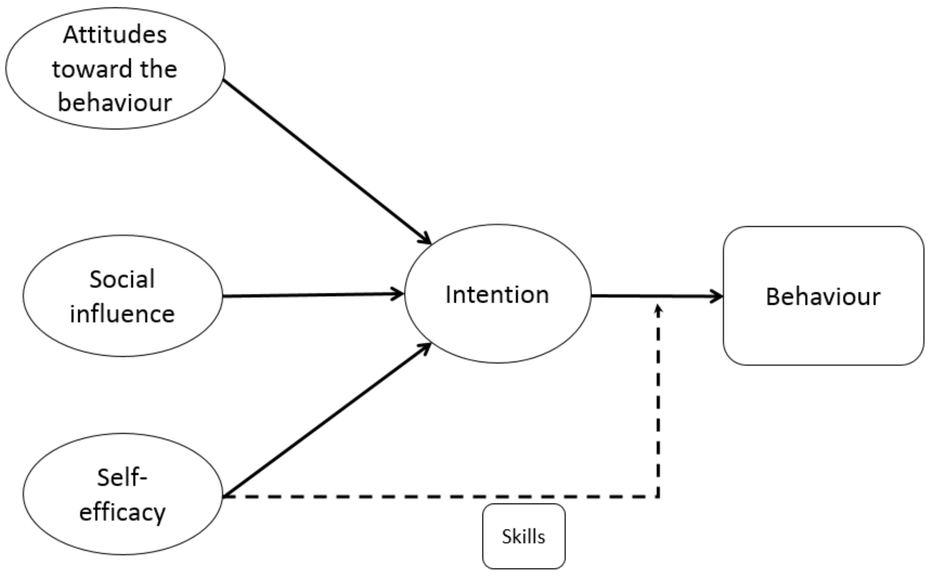
Zoellner et al. (2012)	119	U.S.	Adults	Cross-sectional	BEVQ-19	Behavioural beliefs Attitudes to drink less SSBs, Normative beliefs, Motivation to comply Subjective norm to drink less, Control beliefs, Perceived power, PBC to limit Intention, Implementation intentions	Drinking less than 1 cup of SSB	Sex, age, education level, income level, health status, self-reported height and weight	TPB explained 38% of the variance of SSB intake. Attitudes ($r=0.63$, $p<0.001$), subjective norms ($r=0.36$ $p<0.001$), PBC ($r=0.54$, $p<0.001$) were correlated to intention; and intention was correlated to limiting intake of SSB ($r=-0.51$; $p<0.001$). Attitudes ($\beta=-0.26$, $p<0.01$), subjective norms ($\beta=-0.18$ ($p<0.05$), PBC ($\beta=-0.22$, $p<0.05$) and intention were associated with SSB intake.
Tipton et al. (2014)	165	U.S.	Adults	Cross-sectional	Sugar-Sweetened Drink Questionnaire (SSDQ)	Beliefs and attitudes subjective norm PBC and intentions	Caregivers intentions to serve SSBs to children	N/A	The TPB explained 48% (R2 = 0.48) of variance regarding caregivers' intention to serve SSBs. Attitudes ($\beta=0.43$, $p<0.001$), subjective norm ($\beta=0.31$, $p<0.001$) and PBC ($\beta=0.17$, $p<0.01$) were associated with caregiver intention to serve SSBs
Riebl et al. (2016)	100	U.S.	Adolescents (12-18y) and their parents	Cross-sectional	24 HR (4 times) for adolescents and BEVQ-15 for parents	Attitudes, Subjective norm to limit SSB, PBC to limit SSB, intention to limit SSB	SSB intake	Sex, age, BMI	TPB explain 32% of the variance in adolescents Subjective norm ($\beta=0.57$; $p=0.001$) and PBC ($\beta= 0.39$; $p=0.002$) was associated with intention to limit SSB. Intention to limit was a predictor of SSB intake ($\beta=-0.27$; $P=0.026$).
Choy et al. (2017)	37	U.S.	Children (parents)	Cross-sectional and interviews	FFQ	Parental Attitudes to limit SSB, subjective norm, PBC	Child beverage intake	N/A	Attitudes (1.03, $p< 0.0001$), subjective norms (0.24, $p=0.01$) and PBC (0.72; $p<0.001$) were associated with intentions

PBC: Perceived behaviour control; TPB: Theory of planned behaviour; FFQ: Food frequency questionnaire; 24HR: 24 hours diet recall; BEVQ: Beverage Intake Questionnaire

2.2.2 *Attitude-Social Influence-Self-Efficacy (ASE) model*

The ASE model has been widely used to predict and explain health behaviour. The ASE model resembles the TPB, as both are extensions of the Theory of Reason Action (TRA) (Ajzen and Fishbein, 1980). The TPB and the ASE model integrate two factors from TRA, namely attitudes and subjective norms (later called social influence) but also incorporate a third factor from the Social Learning Theory (Bandura, 1977), self-efficacy (Figure 2.2). Self-efficacy is a person's belief about whether they can perform the desired behaviour and can cope with barriers that may hinder actual performance (Brug et al., 1995).

Figure 2.2 Attitude-Self-Efficacy Model. Adapted from de Vries et al, 1988



Whilst several studies have used the ASE model to predict intake of fruits and vegetables, only one study has used components of the ASE model to predict the intake of SSBs in adolescents. In this study, Van der Horst et al. (2007) assessed the direct and indirect association between the intake of SSBs, perceived parenting styles and ASE model constructs, including positive attitudes towards drinking SSBs, social influences (subjective norms, modelling and social pressure from both peers and parents), and self-efficacy to reduce intake. Results indicated a positive association between SSB intake and these attitudes (β=189; 95% CI: 105, 272.8), self-efficacy (β= -128.2; 95% CI: -194.1, -62.3) and modelling from parents (β= 191.2; 95% CI: 110.6, 271.8). Also, the same ASE model constructs mediated the relationship between perceived parenting styles and adolescents' SSB intake. However, no mediation assessment was performed between the ASE model constructs and intentions, which did not allow the model for SSB intake to be fully tested (van der Horst et al., 2007) Due to the lack of application of the ASE model and the misreporting of the variance of the model, it is difficult to assess its capability to predict intake of SSBs.

2.2.3 Habit Theory

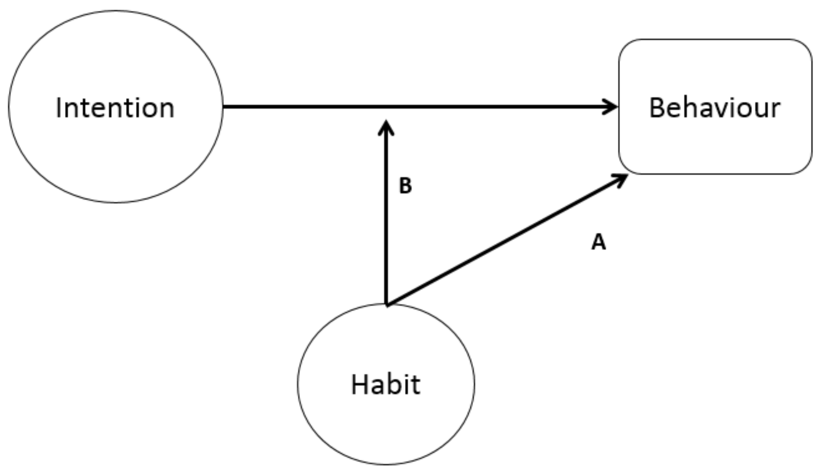
There is a recurring suggestion that habit plays an important role in generating behaviour (Gardner, 2015). In contrast to the TPB and ASE models, habit theory posed that some behaviours are performed with a lack of cognitive processing, triggered by specific environmental cues. According to Gardener (2015), habit is "*a process by which a stimulus automatically generates an impulse towards action, based on learned stimulus-response associations*". This definition of habit incorporates its three components: automaticity, cue-dependency and stimulus response association.

Automaticity is the main component of habit, and according to Bargh (1994), is characterised by lack of conscious intent, lack of control, lack of awareness and mental efficiency. There are two proposed mechanisms for how habit automaticity is triggered. The first is that habits are activated automatically by goals (Verplanken and Faes, 1999). The second mechanism suggests that habits are activated directly by contextual cues, and thus goals have a minimal influence (Wood and Neal, 2009). Empirical evidence suggests that habits of moderate strength are automatically influenced by goals, whereas stronger habits are automatically triggered by context cues (Neal et al., 2012). Thus habitual behaviours are triggered by context cues (cue-dependency) that can be in the physical environment (i.e. locations, times), or in the psychological or social environment (i.e. presence of others, mood states) (Ji and Wood, 2007).

Repeating the behaviour in a particular context or situation reinforces the context-behaviour association in memory. This controls the initiation of the behaviour, passing from a conscious reflective processing system (initiated by intentions) to an automatic impulse system (initiated by environmental cues) (Gardner, 2012). Following this, once the context-behaviour association is acquired, this is activated when the individual encounters the context. This association, however, can only have an effect if the behaviour is frequently performed in a stable context (Neal et al., 2012). For instance, in the case of eating behaviours that are performed every day, several times a day and are mostly performed in a stable context. These have been assumed to be habitual (van't Riet et al., 2011). A meta-analysis of prospective and cross-sectional studies on the effect of habit on dietary behaviour, suggested that habit accounts for 18% of the variance of different dietary behaviours (Gardner et al., 2011).

There are two hypotheses of how habit determines action (Figure 2.3). When contexts are consistently encountered and remain stable habit strength will directly correlate with the behaviour (path A). A total of four studies were found that examined the association between habit strength and SSB intake, all of which found a positive association (Kremers et al., 2007; Tak et al., 2011; van de Gaar et al., 2017; van der Horst et al., 2007).

Figure 2.3 Habit-behaviour relationship. Path A: direct effect of habit on behaviour; Path B: moderating effect of habit on the intention-behaviour relationship. Adapted from Gardner, 2015



On the other hand, path B (Figure 2.3) suggests that habit interacts with intentions in determining behaviour. Triandis (1977) proposed that behaviours that have been frequently repeated in the past are less guided by intention in comparison to new behaviours that require more cognitive effort. Few studies on the domain of fruit, fast food and saturated fat consumption have tested the moderating effect of habit in the relationship between intention and behaviour (Gardner, 2015). Results indicate that when there is a higher habit strength to consume fruits, fast food and saturated fats, the effect of intention-behaviour is attenuated (de Bruijn, 2010; de Bruijn et al., 2008). However, this interaction has not been tested in the domain of SSB intake (Gardner, 2015). Examining this interaction could inform the degree to which SSB intake is a habitual behaviour or a behaviour guided by deliberate intentions (Verplanken and Aarts, 1999).

2.2.4 Environmental Research Framework for Weight Gain Prevention (EnRG)

More recent frameworks have focussed on the inclusion of environmental factors to better explain and predict health behaviours. The EnRG framework proposes that micro-environments (schools, work settings, homes and neighbourhoods) and macro-environments (health systems, governments and food industry) influence energy balance-related behaviours. This association, however, may be mediated by cognitive factors from the TPB and moderated by personal (demographic, personality) and behavioural (habit strength and clustering or the co-occurrence of other behaviours) factors (Kremers et al., 2006) (Figure 2.4)

Figure 2.4 Environmental Research Framework for Weight Gain Prevention, from Kremers et al. (2006)

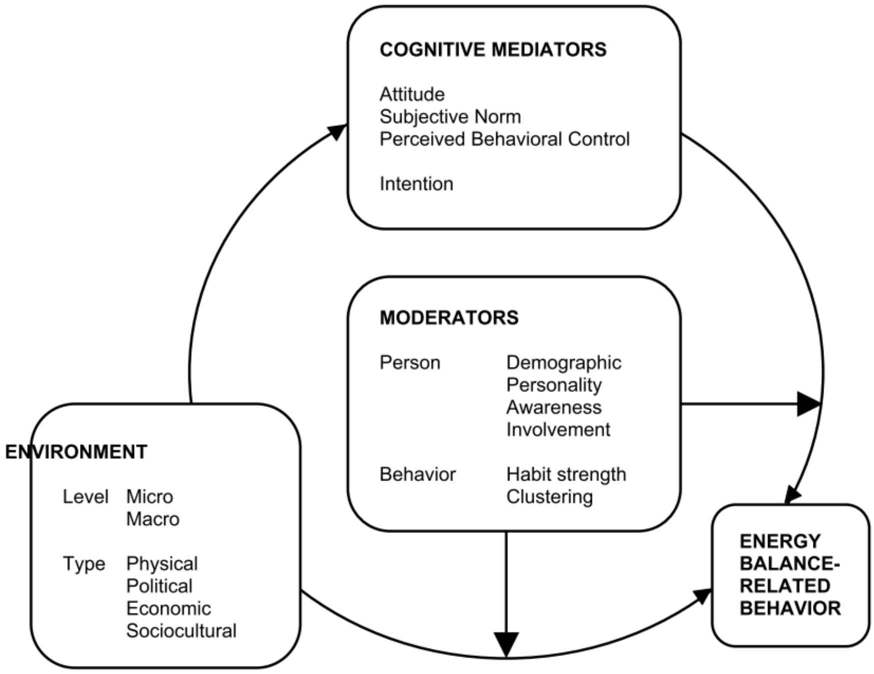


Table 2.3 summarises the studies that have tested the EnRG framework to explain the intake of SSBs. All studies have been conducted among European children and adolescents meaning none have been done among adults or outside Europe. Most studies partially tested the EnRG framework. For instance, four of the five studies (Ezendam et al., 2010; Luszczynska et al., 2013; Tak et al., 2011; van der Horst et al., 2008) tested the EnRG hypothesis that environmental factors influence SSB intake through TPB cognitions. However, one study (van de Gaar et al., 2017) did not assess the mediation of cognitions in the association between environmental factors and SSB intake, their findings indicated a positive relationship between constructs of TPB, habit, home availability, parenting practices and modelling and SSB intake (see Table 2.3). Beyond this, none of the studies assessed the moderation effect of personal and behavioural factors such as habit.

Table 2.3 Summary of studies that have use EnRG framework to understand intake of SSB

Study	Country	N	Population	Design	Diet	Exposure	Outcome	Covariates	Findings
van der Horst et al. (2008)	Netherlands	1293	Adolescents 12-15y	Cross-sectional	FFQ	School availability Distance to food stores. **TPB:** intention to consume, attitude, PBC, and parental norm Modelling peers and parents	SSB intake	Gender, Ethnicity, school level	Intermediate distance (200-300m) to food shop was inversely associated with SSB intake (β=-0.37;p<0.05) Attitudes (β=0.32;p<0.05), parental subjective norm (β=0.20;p<0.05) and intention (β=0.42;p<0.05) were associated with SSB intake. Modelling from friends and parents (β=0.32;p<0.05) was associated with SSB intake.
Ezendam et al. (2010)	Netherlands	348	Adolescents 12-13y	Prospective	FFQ	**TPB:** Attitude to drink less SSBs, Parental subjective norm, PBC (to limit SSB), and intention to change intake Home availability Family rule	Changes in SSB intake	sex, age, ethnicity	Positive attitudes to reduce SSB (OR=0.60, 95%CI:0.36,0.98) and PBC (OR=0.44;95%CI:0.25,0.76) ↓ in SSB intake over time. ↑ home availability was associated with ↑ odds for ↑ intake over time (OR=2.39;95%CI:1·27, 4·51) ↑ restrictions of SSB intake was associated with a ↓ in SSB intake over time (OR=0.54;95%CI: 0.32,0.91)
Tak et al. (2011)	Netherlands	1005	Adolescents 14-15y	Cross-sectional	FFQ	Home availability, and accessibility Parental modelling, and parental rules **TPB**: intention, attitude and parental norm. Habit strength	SSB intake	Sex, age, ethnicity, school level	Intention were associated with SSB intake (β=0.40; 95%CI: 0.29,0.51) ↑ Habit ↑ SSB intake (β=0.59, 95%CI:0.48,0.69) ↑ home availability ↑ SSB intake (β=0.74; 95%CI:0.49,0.99)

Luszczynska et al. (2013)	Netherlands Poland Portugal UK	2764	Adolescents 10-17y	Cross-sectional	FFQ	Parental influence for SSB. home availability and accessibility of SSB, Peer influence on SSB intake and out-of-home accessibility of SSB Nutrition Self-regulation	SSB intake	Age	↑ Home (β= 0.22; p<0.001) and out-of- home accessibility (β= 0.10; p<0.01) of SSB ↑ SSB intake ↓ nutrition self-regulation. ↑ Peers influence (intake disapproval) ↓SSB intake (β= -0.08; p<0.05) and ↑ Peers influence (intake disapproval) ↓SSB intake (β= -0.07; p<0.001)
van de Gaar et al. (2017)	Netherlands	644	Children 6-13y (parents)	Cross-sectional	FFQ	SSB availability at home and school, parenting practices toward SSB intake, rules, modelling from parents **TPB:** attitude, subjective norm, PBC. Habit strength. Taste preferences	Child average intake of SSB per day (litre/day)	Age, gender, ethnic background, parental education	The full model explained 26%variance of the SSB intake. Attitudes to limit SSB (β= -0.07;p<0.01), subjective norm (β= 0.16;p<0.01, PBC (β= 0.05;p<0.05), habit(β=0.20; 95% CI: 0.15, 0.25), home availability (β=-0.04;p<0.05), parenting practices (β= 0.13;p<0.01 and modelling (β= 0.06;p<0.01)were associated with SSB intake

CI: Confidence intervals; OR: Odd ratios; PBC: Perceived behaviour control; TPB: Theory of planned behaviour; FFQ: Food frequency questionnaire

Overall, previous research has tried to understand the intake of SSBs from a theoretical perspective by using mainly cognitive (TPB and ASE model) and impulsive models (habit theory). However, the explicative power of these models is somewhat limited as they do not account for other environmental and social aspects of the behaviours. Although more recent research on the determinants of SSB intake has incorporated different environmental factors associated with SSB intake, like their availability and accessibility at home and school by following a ecological model, like the EnRG framework. Nonetheless, the EnRG framework has not been yet fully tested to assess interactions between the environment and the different cognitions and behaviours that promote the intake of SSBs (findings are discussed in the next section). Moreover, an important limitation of the EnRG framework is that it does not consider any interaction between social factors. To date, no theoretical exploration on SSB intake has yet been performed in Mexico, so consequently less is known about whether previous theoretical approximation is useful to understand SSB intake in the Mexican population.

2.3 Factors that promote SSB intake

In order to understand the rise in SSB intake in Mexico, it is important to review the factors associated with the intake of SSBs. This section summarises the literature on factors that determine SSB intake based on the four levels of influence suggested by the socioecological model: 1) individual or intrapersonal factors; 2) social or interpersonal factors, and environmental factors that are divided in 3) settings or meso-level; and 4) policies or macro-level. Some of the factors that promote intake of SSBs are part of the theoretical models described in section 2.2, some others, like taste preferences, are not linked to any theory.

There was limited literature on the factors related to SSB intake in the Mexican population. Nevertheless, this topic has been widely explored in developed countries, which provides evidence of the possible factors influencing intake of SSBs that can guide the expansion on this type of research in Mexico. These findings, along with the limited data from Mexico, are summarised below.

Most of the research examining factors related to intake of SSBs has been formative research, which has been used to guide the design and implementation of interventions to reduce intake of SSBs. The majority of these studies have been conducted among children and adolescents, so very limited research has focussed on the determinants of SSB intake in adults.

2.3.1 Individual or intrapersonal factors

2.3.1.1 Sociodemographic factors

There is evidence in Mexico suggesting that intake of SSBs varies across socio-demographic factors like age, gender, socio-economic status (SES), region, and area of residence (urban/rural). Adults showed a higher percentage contribution of SSBs to total energy intake than school aged children (β=-3.6; $p<0.01$) and adolescents (β=-1.1; $p<0.01$) (Aburto et al., 2016).

Analysis of the ENSANUT-2006, showed that men have higher total energy intake from SSBs than women (Barquera et al., 2008), however it is difficult to assess if there is a difference between genders, since, for example, alcohol consumption was accounted for in the total energy intake which considerably increased the caloric intake of beverages in men compared to woman. No differences between genders were observed in total energy intake from SSBs in preschool children but for school-aged children, boys showed a higher caloric intake from SSBs than girls (Barquera et al., 2010a). Among adolescents, males consumed more SSBs than females (1 serving/d vs. 0.86 serving/d; $p<0.05$) (Jimenez-Aguilar et al., 2009). In ENSANUT-2012, females showed a lower percentage contribution of SSB to total energy intake (β=-1.7; $p<0.01$) than males (Aburto et al., 2016)

With regards to SES, results from the ENSANUT-2006 suggest that children with higher SES and adults with medium and high SES had greater energy intake from SSBs than those with a low SES (Barquera et al., 2010a, 2008). Similarly, Jimenez-Aguilar et al. (2009) found that high SES adolescents consumed 1.21 more servings of SSBs a day than low and medium SES (0.64 and 1.02

serving/day, respectively, $p=0.05$). Nonetheless, results from ENSANUT-2012 showed no difference in the total energy intake contribution of SSBs by SES in the whole Mexican population (Aburto et al., 2016).

In relation to the area of residence (urban/rural), evidence from ENSANUT-2006 suggested that energy intake from SSBs in pre-school children was higher in rural areas, whereas for school-aged children, the highest calorie intake from SSBs was observed in urban areas ($p<0.05$) (Barquera et al., 2010a). Likewise, energy intake from SSBs in adults was higher in urban than in rural areas ($p<0.05$) (Barquera et al., 2008). Adolescents form urban areas consumed more servings per day of SSBs than those in rural (1.07serving/d vs. 0.64 serving/d; $p<0.05$) (Jimenez-Aguilar et al., 2009). Similarly, data from the ENSANUT-2012 suggested that those residing in urban areas had a higher percentage contribution of SSBs to total energy intake than those residing in rural areas ($\beta=-1.5$; $p<0.01$) (Aburto et al., 2016).

In 2006, pre-school children residing in the South had the highest calorie intake from SSBs, whilst school-aged children and adults living in Mexico City had the highest calorie intake from SSBs (Barquera et al., 2010a). Those adolescents residing in the North had a higher intake of SSBs than those in central Mexico, Mexico City and the South ($p<0.05$) (Jimenez-Aguilar et al., 2009). In 2012, although the intake of SSBs exceeded the caloric recommendation in all regions in Mexico, those in the north region presented a higher percentage contribution of SSB to total intake from SSBs than the central ($\beta=-3.0$; $p<0.01$) and southern regions respectively ($\beta=-2.5$; $p<0.01$) (Aburto et al., 2016). Overall, the evidence presented in this section have been useful to understand average association between sociodemographic variables and SSB intake, however the skewed distribution of SSB intake and the statistical analysis utilised might limit the interpretation of this evidence, especially when trying to understand very high and very low intake of SSBs. This issue is expanded and discussed in Chapter 3 (section 3.1).

2.3.1.2 Taste Preferences toward SSBs

Taste preferences play a major role in SSB intake in young people (Block et al., 2013, Battram et al., 2015). In Mexico, according to the ENSANUT-2016, the main barriers perceived by adults to eating healthily was the taste preferences to consume SSBs. Results also indicated that 82% of the adult population reported liking SSBs, this being higher in urban areas relative to rural areas (Hernández Ávila et al., 2016). However, less is known about whether the taste preference translates to a higher intake among the Mexican population.

Research in other countries has examined this in more detail, for instance Bere et al. (2008) conducted a quantitative cross-sectional study and found that Norwegian adolescents with high taste preferences were 5.5 times (95% CI: 4.0, 7.6) more likely to drink SSBs compared to those with low taste preferences. Likewise, another study among U.S. children found that those who strongly liked the taste of caloric soda were 4.5 times more likely to drink these beverages ≥5 times per week compared to those who responded `like or dislike' the taste of caloric sodas (Grimm et al., 2004).

Qualitative studies among young people (USA) and children (Canada) also suggest that taste is a key driver of SSBs choices (Battram et al., 2015; Block et al., 2013). A qualitative study by Visram et al. (2017) suggested that taste influenced adolescents' decision to consume energy drinks (EDs). However, using a sample of young Australians, Francis et al. (2017) found that taste has a mixed impact on choice, as conversely some participants mentioned that it was a factor preventing them from consuming EDs. Taste, as a driver of ED consumption, was also found by Bunting (2013), where pleasantness was seen as a more important factor for consuming EDs overriding any negative physiological effects caused by them.

2.3.1.3 Psychosocial factors

2.3.1.3.1 Attitudes

Positive attitudes towards drinking SSBs have been directly and indirectly (i.e. mediated by another factor) associated with the intake of SSBs[3]. For example, Bere et al. (2008) found a higher odds of carbonated soda intake for those adolescents with positive attitudes, compared to adolescents with negative attitudes (OR=1.9; 95% CI: 1.4, 2.7) (Bere et al., 2008). Similarly, in two samples of Dutch adolescents, the higher the positive attitudes towards drinking SSBs, the higher the reported SSB intake was, by 189.3 ml (95% CI:105.8, 272.8) (van der Horst et al., 2007) and 324 ml ($p<0.01$) (van der Horst et al., 2008) respectively. Similar results were observed in U.S. adults, where negative attitudes for drinking less than a cup of SSBs was negatively associated with actual intake ($\beta=-0.26$, $p<0.01$) (Zoellner et al., 2012a). Moreover, indirect associations between attitudes and SSB intake were reported in studies using the TPB, which suggests that positive attitudes toward drinking SSBs predict behaviour via intentions (Ajzen and Driver, 1991). Research on adolescents has consistently suggested that attitudes are a good predictor of behavioural intentions to drink SSBs (De Bruijn et al., 2007; Kassem et al., 2003; Kassem and Lee, 2004) (Table 2.2).

Qualitative studies have explored in depth the beliefs that influence positive attitudes towards SSB intake. For instance, a study among caregivers of pre-school children suggested that convenience, packaging, and the fact that children loved the taste facilitated positive attitudes toward SSBs, which subsequently facilitated serving SSBs to children as a reward or a means to control their behaviour (Tipton, 2014a). Another qualitative study among U.S. adults suggested that the taste, the caffeine content and efficacy as a thirst quencher were attributed as plus factors contributing to positive attitudes to drinking SSBs, (Zoellner et al., 2012b).

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[3] Direct effect and total effect are used interchangeably in this chapter. Similarly, indirect effect, partial effect and mediator are used interchangeably. This based with the terms used in the original paper used to in the text

2.3.1.3.2 Social norms

Social norm refers to one's beliefs about the actions and beliefs of others within a social group (Ball et al., 2010; Lally et al., 2011a). There are two types of social norms: descriptive norms, that refers to what the individual think is important other do; and injunctive norms that refers to doing what others think one should do (Cialdini, 1998). There is evidence suggesting that social norms predict the intake of SSB in different population groups. For instance, Lally et al. (2011a) examined the association between adolescents' intake of SSBs and descriptive and injunctive norms. Nonetheless, only descriptive norms predicted SSB intake, as the more drinks adolescents perceived their peers consumed, the more SSBs they drank themselves (β=0.44, p<0.01). Ball et al. (2010) also examined descriptive norms for soda intake among Australian adults, and found that those with higher descriptive norms were more likely to have higher soda intake, compared to those with lower descriptive norms (OR=1.33, 95% CI: 1.18, 1.50).

In a cross-sectional study among U.S. children, those who perceived that their friends consumed soda regularly were nearly twice (OR=1.84; 95% CI: 1.17, 2.88) as more likely to drink soda as those who perceived that their friends did not drink soda (Grimm et al., 2004). One study examined this relationship further by comparing perceived peers' intake with their school groups' and peers' self-reported intake. Perkin et al. (2010) found that perceived peers' SSB intake predicted the actual intake of children and adolescents in the U.S. (β=0.59, p<0.001). The analysis also showed that 76% of children and adolescents in the sample overestimated their school grade peers' intake of SSBs. Evidence indicates that perceptions of peers' intake of SSBs is a factor that consistently predict SSB intake in children and adolescents. However, less is known about whether the intake of SSBs in Mexico can be predicted by what children's and adolescents' peers consume and therefore this issue requires further investigation.

An equivalent term to social norms is subjective norm which is constructs from the TPB (Ball et al., 2010; Lally et al., 2011a). Subjective norms refer to individual's perceptions of what other people believe about performing certain behaviours Previous studies based on TPB to explain the intake of SSBs in adolescents found that parental and peer subjective norms predict intake of SSBs but the effect is mediated by intention to drink SSBs (De Bruijn et al., 2007; Kassem et al., 2003; Kassem and Lee, 2004). Nonetheless, few studies have also assessed the total effect of parental subjective norms on adolescents' intake (Ezendam et al., 2010; Tak et al., 2011; van der Horst et al., 2008, 2007). However, one study among Dutch adolescents did report a positive association in this regard ($\beta=0.203$, $p<0.001$) (van der Horst et al., 2008).

2.3.1.3.3 Perceived control over SSB intake

Perceived behavioural control (PBC) refers to individuals' perception of control over certain behaviours (Ajzen and Driver, 1991). Qualitative research exploring the control belief that preceded PBC suggested that availability and convenience, size of can, low cost, taste, and the dislike of SSB alternatives affected the PBC to limit drinking SSBs among adults (Zoellner et al., 2012b). Although a few studies investigated direct associations between PBC and SSB intake among adolescents (Ezendam et al., 2010; Kassem et al., 2003; Kassem and Lee, 2004; van der Horst et al., 2008), only three of these found a direct association between PBC and SSB intake (Ezendam et al., 2010; Kassem et al., 2003; Kassem and Lee, 2004). A short cohort study showed that positive PBC to limit SSB intake was associated with a higher probability to decrease SSB intake over time (OR=0.53, 95% CI=0.30,0.97) (Ezendam et al., 2010). Nonetheless, other studies examining this relationship have found that the effect of PBC on SSB intake is mediated by intentions. For instance, adolescents' PBC to drink soda was associated with intake via intentions to consume soda in females ($\beta=0.24$; $p<0.0001$) and in males ($\beta=0.28p<0.0001$) (Kassem et al., 2003; Kassem and Lee, 2004).

A similar concept to PBC is perceived self-efficacy, which refers to individuals' beliefs about capabilities to perform a desired behaviour and to cope with barriers that may hinder actual performance (De Vries et al., 1998). Two studies have examined the relationship between self-efficacy and SSB intake (Haerens et al., 2008; van der Horst et al., 2007), however only one study found a positive association, where high self-efficacy to limit SSBs was associated with a lower intake of SSBs by 128.2 ml (95% CI:-194.1, -62.3) in Dutch adolescents (van der Horst et al., 2007). Whilst the other study among Belgian adolescents found no association between self-efficacy and soda intake (boys -0.02 glasses/day; 95% CI:-0.52,0.42 and girls -0.01 glasses/day; 95% CI: -0.37,0.31) (Haerens et al., 2008). Although the demographic in both studies are similar in term of age, the fundamental difference between the studies is that the Belgian study assesses the association between self-efficacy and soda while the Dutch study is for all SSBs. Thus, it could be that the adolescents might have lower levels of behavioural control for soda intake than for a wider variety of SSBs

2.3.1.3.4 Habit

Habit is another concept hypothesised as being a predictor of the intake of SSBs (see section 2.2.3). Evidence from cross-sectional studies showed that a higher habit strength towards drinking SSBs is associated with adolescents' intake of SSBs (β=0.48; $P<0.001$) (Kremers et al., 2007). Moreover, two studies among Dutch adolescents examined the direct and mediated effect of habit in SSB intake. Van der Horst (2007) found that an increase in habit strength for drinking SSBs led to an increment of 35ml/day of SSBs (95% CI: 28.8, 42.1) and that habit mediated the association between parenting practices and adolescents' daily intake of SSBs. The second Dutch study not only found that a higher habit strength was positively associated with the intake of SSBs (β=0.59, 95% CI 0.48,0.69) but also that habit mediated the association between home availability and SSB intake (Tak et al., 2011). This indicates that the role of the habit might go further than predicting SSB intake in adolescents, in that it might also interact with other determinants of SSB intake. Nonetheless, it is also important to examine the role of habit in SSB intake in adults, as there is no current evidence that supports this link.

Taken together, evidence on the role of individual factors in SSB intake in Mexico suggests that sociodemographic factors like age, gender, area and region of residence are all associated with SSB intake. There is some indication that taste preference is a major factor that promotes intake of SSBs among Mexican adults, but this needs to be further corroborated in children and adolescents. However, none of the psychosocial factors discussed in this section have been examined in relation to SSB intake in Mexico, which are important to understand the high SSB intake observed in this country (Aburto et al., 2016) and for the development of future interventions to reduce the intake of SSBs in the Mexican population.

2.3.2 Social or interpersonal factors

Eating behaviours are strongly influenced by individuals' social contexts (Story et al., 2002) and the intake of SSBs is no exception. Evidence examining the role of social influences in the intake of SSBs has shown that family, friends and peer groups are some of the social factors that promote intake. Nonetheless, the majority of research to date has explored the social environment of SSB intake only among children and adolescents, and no evidence examining this link has been carried out for adults, or for the Mexican population.

2.3.2.1 Parental influences

Parents determine the food environment of children and adolescents by deciding what foods are available at home and serving as role models with their own food choices (Vereecken et al., 2010). Adolescents and children's intake of SSBs has been associated with several parental behaviours, such as permissive food rules and parental intake of SSBs that serve as modelling to young people (Bogart et al., 2013).

A longitudinal study in Norway examined the relationship between parental education and adolescents' intake of SSBs. Findings suggested that low parental education (12 years or less) is associated with a higher intake of soft drinks over time relative to high parental education (β=1.9, SE=0.6, $p<0.05$) (Totland et al., 2013). A cross-sectional study among Australian adolescents found a partial association between high parental education and children's frequency of intake of carbonated soft drinks, and suggested this association was mediated by attitudes (Pettigrew et al., 2015).

The association between parental intake of SSBs and children and adolescents' SSB intake has been examined only through cross-sectional studies. In some studies, parental intake was assessed via parental self-reports using a Food Frequency Questionnaire (FFQ). For instance, in one study in eight European countries, self-reported parental intake of carbonated drinks was associated with children's intake of carbonated drinks, but only in four countries (Belgium, Greece, Hungary and Switzerland) (β=0.059 log, $p<0.05$) (Van Lippevelde et al., 2013). Nonetheless, a separate study in the Netherlands found that when parents consume a litre of SSBs per week, their children consumed 460 ml of SSB more per week (95% CI: 0.40, 0.52) than their parents (van Ansem et al., 2014). Among Latino adolescents and their parents residing in the U.S., parental intake of soda and fruit-flavoured drinks was associated with greater intake of soda (β=0.05 cups, $p<0.05$) and fruit-flavoured drinks among adolescents (β=0.05 cups, $p<0.05$) (Bogart et al., 2017).

Parental influence has also been gauged via children and adolescent's perceptions of their parents' intake of SSBs, which some authors referred to as perceived parental modelling (Bere et al., 2008; van Ansem et al., 2014). U.S. children and adolescents who perceived that their parents regularly drink carbonated SSBs were almost three times more likely to drink carbonated SSBs, compared with those who perceived their parents did not regularly consume these beverages (OR=2.88; 95% CI: 1.76, 4.72) (Grimm et al., 2004). In the Netherlands, higher parental modelling was positively associated with higher SSB intake in adolescents (Tak et al., 2011; van der Horst et al., 2008, 2007) and children (van de Gaar et al., 2017). In the study by Bere et al. (2008), modelling was associated with a higher risk of increased soda intake among Norwegian adolescents (OR=3.8; 95% CI: 2.8, 5.3). However, assessment of modelling included modelling from family members (parents and siblings) and modelling from best friends, thus making it difficult to assess the independent effect of parents in this association. By separating the effect role of different family members and between best friends and peers from parental influences can inform the social relationships that are most important for the intake of SSBs in younger populations.

2.3.2.1.1 Parenting practices

Parenting practices are defined as the specific behaviours that parents use to raise their children (van de Gaar et al., 2017). In the context of dietary intake, parenting practices are often reflected in food rules (van der Horst et al., 2007). There is some evidence suggesting that parenting practices are directly associated with SSB intake. One longitudinal study investigated this association, suggesting that for those adolescents who had parental restrictions on SSB intake in place at the baseline, SSB intake decreased over a 4-month period compared to those with non-restrictive SSB rules (OR=0.54,0.32,0.91) (Ezendam et al., 2010). The rest of the evidence comes from cross-sectional studies across Europe. In this vein, Van Lippevelde (2013) showed that high permissiveness to drink carbonated soda was related to higher children's intake of soda in eight European countries (β= 0.076, SE: 0.016, $P<0.05$). Conversely, having lower restriction rules towards drinking SSBs was associated with increased odds of high consumption in Belgian boys and girls (OR= 3.38, 95% CI: 2.87, 3.97 and OR=3.11, 95% CI: 2.61, 3.72, respectively), as well as among Italian boys and girls (OR= 3.38,95% CI: 2.67, 4.29 and OR=3.88, 95% CI: 2.88, 5.23, respectively) (Verzeletti et al., 2010).

The cross-sectional evidence from van der Horst et al. (2007) and de Bruijn et al. (2007) showed that as parenting practices became more restrictive, the intake of caloric soda decreased (β=-0.38, $p<0.001$ and β=-0.22, $p=0.002$, respectively) in Dutch adolescents, whereas Haerens et al. (2008) found no association between parental food rules and the intake of SSBs in Belgian children. Similarly, disapproval from parents to drink SSBs was negatively associated with intake in preadolescents and early adolescents (β= -0.13, $p<0.001$ and β= -0.07, $p<0.01$ respectively), but not for mid-adolescents. This indicates that depending on the age of adolescents, parents influence on their children's intake of SSBs differently probably differs (Luszczynska et al., 2013).

2.3.2.2 Peer influence

Previous evidence indicates that children, adolescents and young adults tend to have dietary patterns that are similar to their peers (Pelletier et al., 2014). This section presents the evidence examining the influences that peers have on individuals' intake of SSBs. According to the literature, peer influence could promote intake of SSBs through modelling (defined as the behaviour of important others), as an association has been found between the individual intake of SSB of the adolescents and the intake of their peers. For instance, adolescents intake of sport drinks was associated with the intake of their friends group and best friends (Bruening et al., 2014). Similarly, in another study soda intake was predicted by their friendship group's soda intake ($\beta=0.20$, $p<0.001$), indicating that sodas were consumed by adolescents who had soda consuming friends (Wouters et al., 2010). Nonetheless, mixed results were observed among two samples of Dutch adolescents, where in one study peer modelling was positively associated with SSB intake ($\beta=0.190$ litre/day; $p<0.001$) (van der Horst et al., 2008). Meanwhile in the other study peer modelling showed no association with the intake of SSBs ($\beta= -28.1$ ml/day, 95% CI: -132.7, 76.4) (van der Horst et al., 2007).

Qualitative evidence regarding the intake of SSBs has emphasised the role of peer pressure. In children, peer pressure to consume SSBs was something that promoted intake among Canadian children (Battram et al., 2015). Other studies have focused only on intake of EDs, for instance a focus group study among Australian young people (12-25years) reported that ED intake was facilitated by peer pressure, however peer pressure to drink EDs was perceived to be higher in adolescents than in young adults (Francis et al., 2017). In consonance with this, another study conducted in New Zealand suggested that adolescents, compared to young adults, appeared more susceptible to peer influences with regards to ED consumption (Bunting et al., 2013), indicating that age could play a role in how peer pressure influences the intake of SSBs. To support this point further, a cross-sectional study found that disapproval to consuming SSBs from peers appeared to influence SSB intake among mid adolescents (-0.08, $p<0.05$); however, there was no association for pre and early adolescents (Luszczynska et al., 2013). Again, this may indicate that level of influence is contingent upon the stage of adolescence.

Overall, social factors play a major role in determining the intake of SSBs in children and adolescents. For instance, the influence of parents through modelling and parenting practices seems to be decisive in what children and adolescents consider to be acceptable to drink. Also, parental level education appears to influence the attitudes toward drinking SSBs, which might contribute to the normalisation of the intake of SSBs within the family environment. Moreover, the evidence suggests that peers can play a major role in the intake of SSBs. Children and adolescents often perceived that their peers consume SSBs. However, evidence suggested some overestimation of peers' intake, which clearly has the potential to promote the intake of SSBs. Nonetheless, once again, evidence is scarce for adults, apart from one study that suggested that descriptive norms could influence their intake. Less is known about what other social factors could promote the intake of SSBs in this age group. Finally, no research in Mexico has evaluated the role of family and peers in the intake of SSBs. This is particularly important to consider because the family culture in Mexico differs substantially from the U.S. and Europe and therefore requires to be taken into consideration when studying SSB intake in the Mexican population.

2.3.3 Meso-level factors

According to Kremers et al.(2007), individuals interact with multiple settings namely their home, neighbourhoods, schools and workplaces; and these settings are known to influence the availability and accessibility of food (Story et al., 2002). Recent evidence has pointed out the link between environmental factors and intake of SSBs. Because research investigating this relationship has been mainly conducted among young people, the focus has been on settings that are relevant for children and adolescents, in this case the home, schools and the built environment that surround these two contexts. Therefore, this section reviews available literature of the role of different setting in the intake of SSBs.

2.3.3.1 Home environment

2.3.3.1.1 Home availability

Home availability refers to whether SSBs are present in the home environment. The effect of home availability and daily intake of SSBs has been widely investigated. In a longitudinal study among Norwegian adolescents, baseline availability of soda at home was positively associated with adolescents' soda intake after 20 months (β=1.6 dl/week, SE=0.5, $p<0.05$). Likewise, a four-month longitudinal study in Dutch adolescents showed that the higher the home availability of SSBs, the more likely adolescents were to increase their SSB intake over time (OR=2.39, 95% CI= 1.27, 4.51) (Ezendam et al., 2012).

Evidence from cross-sectional studies has also consistently suggested that home availability of SSBs is associated with increased intake, for example among Dutch adolescents (β=0.745, 95% CI=0.49, 0.99) (Tak et al., 2011). Comparable results were found for Dutch children, those who reported having SSBs always available at home consumed 0.96 litres of SSBs more per week, than those who reported not always having SSBs at home (van Ansem et al., 2014). Moreover, Belgian male adolescents who had higher home availability of unhealthy food products were more likely to consume soft drinks (β=0.20, 95% CI=0.2, 1.4), however no association was found for female adolescents (Haerens et al., 2008). Similarly, in a representative sample of Australian adolescents, those who reported 'usually' having SSBs available at home were more likely to consume ≥5 cups/week of SSBs than those who reported never having SSB available at home (AOR=4.63, 95% CI: 3.48, 6.17) (Hebden et al., 2013). When sodas were available at home, U.S. children were almost three time more likely to consume them than those who reported no availability at home (2.82, 95% CI= 1.51. 5.29) (Grimm et al., 2004).

Qualitative evidence from Latino youth living in the U.S. suggested that some adolescents drank SSBs because they were available at home (Bogart et al., 2013). Moreover, Hattersley et al. (2009) explored the cues that prompt SSB intake among Australian young adults and found that availability of SSBs at home, as well as in other social settings, provoked the intake of SSBs.

2.3.3.1.2 Home accessibility

Fewer studies have examined the relationship between the home accessibility of SSBs and intake. In the context of food environments accessibility may be more inherently geographic as it refers to the location of the food supply and the ease of getting to that location (Caspi et al., 2012). The term is very similar to availability; however, food items may be at home but not accessible to the children or adolescents due to parental restrictions.

Longitudinal evidence has suggested that perceived that home accessibility of soda by mothers, fathers and adolescents at the baseline was positively associated with adolescents' intake after 20 months (adolescents β=1.6 dl/week, $p<0.001$, mothers β=1.4 dl/week, $p<0.001$ and fathers β=0.7 dl/week, $p<0.05$) (Totland et al., 2013). Comparable results were reported in cross-sectional studies. Norwegian adolescents with high home accessibility to soda were five times more likely to consume higher amounts of soda (OR=5.0; 95% CI: 3.6, 6.8) (Bere et al., 2008). Similar findings were reported for an Australian sample of adolescents. Those who usually had access to SSBs during meals at home were also more likely to consume ≥5 cups of SSBs per week (AOR= 9.83, 95% CI=6.0, 15.9) (Hebden et al., 2013). Further supporting the link between accessibility of SSBs with intake, suggesting that lower accessibility at home was associated with lower SSB intake in adolescents, however the association was stronger for pre-adolescents (β=0.30, $p<.001$) than early and mid- adolescents (Luszczynska et al., 2013).

2.5.3.1 School environment

Children and adolescents spend most of their day in school, therefore the food environment at school can represent an important influence on beverage choices.

2.3.3.1.3 School availability and accessibility

Similar to home availability, the availability of SSBs in the school context has shown to play a role in children and adolescents' beverage intake. Despite the scarce evidence investigating the effect of school availability of SSBs and intake in Mexico, one study used national representative data (ENSANUT-2006) of Mexican school children (n=9537) to examine the availability of SSBs at school through asking the children if certain food items were available at school. Six percent of the children reported availability of SSBs in schools, however it is not known if the availability was associated with children's intake (Shamah-Levy et al., 2011). However, the data collection for this study was before the implementation of school policies that restricted the sales of SSBs and other energy dense foods (see section 2.4.1). Due to the lack of evidence regarding changes in availability of SSB post- policy implementation, less is known about the current school context of SSBs.

Cross-sectional findings showed that U.S. adolescents who reported using vending machines 1-3 times and >4 times per week were more likely to drink more SSB servings per day (β=0.21, 95% CI: 0.08, 0.33 and β=0.71, 95% CI: 0.50, 0.93 respectively), compared to adolescents who reported no access to vending machines (Wiecha et al., 2006). School availability of SSBs increased the probability of SSB intake among school-aged children in the U.S. (1.38 (95% CI: 1.11, 1.70); boys were more likely to have a higher intake due to availability than girls (OR= 1.36, 95% CI= 1.10, 1.67, $p<0.01$). Also, Australian adolescents who bought SSBs at the school canteen and at vending machines were more likely to drink SSBs (AOR=2.90, 95% CI = 2.26, 3.73 and AOR=1.51, 95% CI: 0.98, 2.31, respectively), than those who bought less that a cup of SSB a week (Hebden et al., 2013). Apart from the effect of school availability on the intake of SSBs, no other factors from the school environment have been investigated.

2.3.3.2 Food environments near schools

One study in Mexico used a nationally representative sample of Mexican school-aged children to assess the availability of SSBs (yes/no) on children's journeys to and from school. The question referred to whether SSBs were available through purchase or as a gift from other people before and after school. Twenty-four percent of children reported availability of SSBs on their way to school, whereas 9% reported SSB availability on their journey from school to their home (Shamah-Levy et al., 2011). However, the study did not provide information regarding the locations where SSBs were available for purchasing, or whether the availability influenced the intake of SSBs. A more recent study found 103 convenience stores around 43 school in two cities in Mexico and these were more frequently observed near public schools than private schools (Barquera et al., 2018). It is possible that the food environment surrounding schools and homes is facilitating SSB accessibility, but further research is needed to examine this hypothesis.

Nonetheless, research in the Netherlands and England has explored the SSB context around schools in more detail. Van der Horst et al. (2008) found an inverse association between intermediate distance (200-300 meters) to the nearest shop from school and the intake of soft drinks (β=-0.246 litre/day, $p<0.01$), compared to those shops that were <200 meters away. This suggests that the closer the food shop, the higher the intake in Dutch adolescents. Another study mapped the journeys to and from school of 19 English adolescents (11-15y and 17-18y), where 25 premises that sold SSBs were found within 400 meters of school entrances. Seventy-four percent of the sample reported purchasing SSBs on their journey to or from school, indicating that access to SSB retailers in the school fringe are influencing their intake (Ennis et al., 2014).

Furthermore, children and adolescents who participated in a qualitative study in England reported drinking EDs in a number of public spaces they normally frequented, such as leisure facilities and on their journey to and from school; they referred to the ease of accessing EDs, mostly referring to the widespread availability of EDs in shops near schools (Visram et al., 2017). Comparable findings were observed in a sample of Australian young people who mentioned that EDs are highly accessible in different contexts including shops, leisure activities, schools and universities (Francis et al., 2017). Results from children in Canada also supported the accessibility of SSBs in the out-of- home environment, such as sports arenas and friends' houses, as an influencing factor of SSB intake (Battram et al., 2015).

Overall, settings, namely home, school and neighbourhood food environment, consistently promote the intake of SSBs through enhanced availability and accessibility. There is a lack of exploration of the home environment in terms of SSB intake in Mexico, as no evidence suggests the aforementioned factors are associated with the intake among the Mexican population. Moreover, although there is some evidence suggesting that schools' fringe in Mexico promotes SSB intake, there is no evidence following the policy implementation (see section 2.4.1) to suggest that this is the case within schools. Therefore, further research is needed to investigate the home environments and the current state of schools' SSB environment.

2.3.4 Macro-level factors

The macro-environment accounts for governments, health systems and the food industry (Kremers et al., 2006). The influence of macro-environments is more distal to individuals but can affect behaviour at a societal level (Story et al., 2002). The following subsections present a summary of the literature on the components of the macro-environment that might promote the intake of SSBs.

2.3.4.1 Access to drinking water

It has been suggested that the lack of potable water in schools and households may play a role in the high intake of SSBs by Mexican adolescents (Barquera et al., 2010a; Piernas et al., 2014). It is estimated that 8 million households in Mexico have no access to potable water on a daily basis (Ortega-Castaneda and Vega, 2016), which inclines people towards purchasing bottled water and SSBs. However, no empirical work has been conducted in Mexico that supports the hypothesis that the lack of drinking water is a contributing factor to the intake of SSBs.

2.3.4.2 Media and marketing

Food marketing in the form of TV advertisements has an impact on food choices and calorie intake among children (Boyland and Halford, 2013; Halford et al., 2007). There is evidence in Mexico that supports the heavy marketing of SSBs. In 2008, a study recorded and analysed 235 hours of national TV and found that 50% of food advertisements were targeted at children. Also, 221 advertisements were promoting SSBs, from which 54% were targeted at children (Ramírez-Ley et al., 2009). A similar study reported that a higher proportion of advertisements were shown during children's programme times than during general audience programme times. Twenty-nine percent of food advertisements during children's TV programmes were for SSBs (Pérez-Salgado et al., 2010). Moreover, a recent study used geographic information systems (GIS) to assess food advertisements around 43 schools in two cities in Mexico. A total of 278 food advertisement in the form of special offers, posters, animated and illuminated advertisement were found around schools from which 51% were for SSBs (Barquera et al., 2018). Despite the evidence suggesting the heavy marketing of SSBs in Mexico, especially to children and around schools, no study has assessed the role of SSB marketing on the intake of SSBs. However, one cross-sectional study found a positive association between SSB intake and TV viewing, where watching $\geq$14 to

21 hr/week of TV was associated with an increase in the intake of SSBs by 1.07 servings/day (240ml) ($p=0.05$) (Jimenez-Aguilar et al., 2009).

Nonetheless, research in developed countries has suggested that after controlling for gender and SES, TV viewing and frequency of commercial TV use were associated with positive attitudes towards consuming carbonated soft drinks ($\beta=0.22$, $p<0.001$ and $\beta=0.10$, $p<0.01$) among Australian children (Dixon et al., 2007). Moreover, qualitative research in schoolchildren highlighted the role of advertising campaigns on influencing intake of SSBs, because such campaigns are perceived as attractive by children and encourage them to try certain sugar-containing beverages (Battram et al., 2015). In a focus group study among young adults, Hattersley et al. (2009) found that the marketing of SSBs affected genders differently, with male participants being more influenced by the marketing of soda, while females were more influenced by the marketing of fruit juices.

In the case of EDs, English children and adolescents stated that media campaigns including internet pop-ups or banners, TV, bus stops, supermarket deals and the sponsorship of events promoted the purchase and intake of ED (Visram et al., 2017). Comparable, evidence also suggested that heavy TV and online marketing of EDs in Australia and New Zealand promoted the intake of EDs, as advertising is often perceived as funny and entertaining (Francis et al., 2017) and because the advertising's humour encouraged specific behaviours within social groups (Bunting et al., 2013)

2.3.4.3 Price

Price can be both a facilitator and a barrier for the purchasing of SSBs. Qualitative work in adolescents has suggested that low prices of SSBs can facilitate purchases (Block et al., 2013). Also, a focus group study among Latino parents of adolescents living in the U.S. suggested that parents purchase SSBs for home consumption mainly because they are inexpensive (Bogart et al., 2013). Moreover, qualitative research on EDs among children and adolescent in England highlighted that some supermarket own brand energy drinks were the cheaper option among the SSBs and bottled water available, influencing children and adolescent to purchase them (Visram et al., 2017). Contrasting findings around the cost of EDs were reported by Francis (2017), as some Australian youths mentioned that they did not buy EDs because they were expensive, however, others said that buying them in multipacks was cheaper, which facilitated their intake. Another study in England children noted that price was not relevant for younger participants, while older participants were more aware of the price and therefore tried to find cheaper SSB options (Ennis et al., 2014). In the case of Mexico, although there is evidence to suggest that there is an inverse relationship between prices and demand (negative elasticity, the higher the price the demand decreases) (Grogger, 2015; Urzúa Carlos M, 2008), there is no evidence assessing the importance of price in decision making to purchase SSBs and how this may vary across different population groups.

2.3.4.4 Cultural factors

The only study that has investigated the cultural determinants of SSB intake among the Mexican population, using qualitative methods, was conducted among children (9-10y) in Mexico City and explored socio-cultural factors that motivate SSB intake. Results identified three principles that may influence SSB intake in children: the role that SSBs play in social events, the combination of savoury foods with sweet drinks and children's perceptions that water intake is limited to physical activity episodes (Theodore et al., 2011). To date, no other study has examined the context surrounding adolescents' intake of SSBs, therefore very little is known about what other cultural factors are relevant for the intake of SSBs in this age group in Mexico.

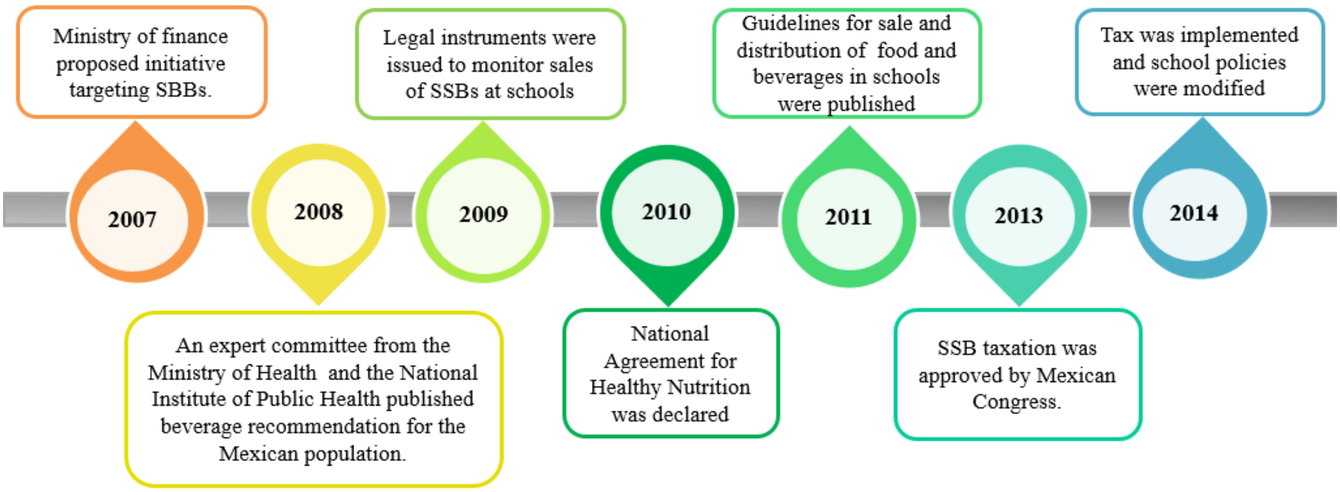
Overall, despite there being some evidence suggesting that limited access to potable water, heavy marketing, price and cultural factors play a role in the intake of SSBs in Mexico, international literature has provided evidence on the role of individual factors (taste, psychological factors like habit), social factors (parents and peers influence) and meso-level factors (home and school food environments) in the intake of SSBs. No studies to date have examined these factors' relationship with the actual intake of SSBs in any population group in Mexico.

2.4 Policy approaches to reduce SSB intake in Mexico

There is a lack of information on how the different factors identified above are associated with SSB intake in Mexico. This has prevented the development and implementation of multi-level interventions to reduce the intake of SSBs. Nonetheless, an influence level that has been receiving attention in the last decade is the food policy environment. Food policies have mainly focussed on the implementation of top-down approaches in order to have a direct impact on SSB intake. A review of these policies is presented below.

Following the publication of the results from the ENSANUT-2006 that reported an increase in the prevalence of obesity in Mexico (Olaiz-Fernández et al., 2006), the public health agenda focused on identifying approaches to decrease obesity rates and prevent NCDs. Due to the increase in the intake of SSBs and its association with overweight and obesity, different sectors of the Mexican Government started to propose policy initiatives to reduce the intake of SSBs among the Mexican population (Figure 2.5).

Figure 2.5 Timeline illustrating actions from Mexican institutions to reduce SSB intake



After the first approach of the Ministry of Finance to tax SSBs in 2007 was blocked by legislators, due to the potential detrimental effect on industry jobs

(Moise et al., 2011), the Mexican Ministry of Health (MOH, together with the National Institute of Public Health, established an expert committee to create beverage consumption recommendations for the Mexican population, with the purpose of developing evidence-based guidelines to aid government officials and health professionals. The expert committee classified beverages into six levels, ranging from the healthiest to the least healthy (Rivera et al., 2008a):

a) **Level 1:** water
b) **Level 2:** skim or low fat (1%) milk and sugar-free soy beverages
c) **Level 3:** coffee and tea without sugar
d) **Level 4:** non-caloric beverages with artificial sweeteners
e) **Level 5:** beverages with high caloric content and limited health benefits (fruit juices, whole milk, and fruit smoothies with sugar or honey; alcoholic and sports drinks)
f) **Level 6:** beverages high in sugar and with low nutritional value (SSBs).

The expert committee also provided a set of recommendations to the education sector, to the industry and to other governmental sectors to support the promotion of these guidelines and advocated taxation of SSBs (Rivera et al., 2008b).

In 2009, several legal instruments were issued with the objective of monitoring sales of SSBs in schools, but these actions were highly criticised by the Education workers' Trade Union and the industry (Moise et al., 2011). By 2010, the MOH declared the National Agreement for Healthy Nutrition [Acuerdo Nacional para la Salud Alimentaría (ANSA) as per its acronym in Spanish], which was presented with the goal of reversing rates of overweight in preschool children, halting the growth of overweight in children and adolescents and delaying the growth of overweight in adults (Hernández and Martínez, 2011). The ANSA is constituted by 10 strategies which are presented in Table 2.4.

Table 2.4 Ten strategic objectives of the National Agreement for Healthy Nutrition (ANSA in Spanish). Adapted from Hernandez and Martinez, 2011

1) Promote physical activity in school, work, community and recreational environments with the collaboration of public, private and social sectors
2) Increase the availability, accessibility and consumption of plain drinking water
3) Reduce the consumption of fats and sugar in beverages
4) Increase daily intake of fruits and vegetables, legumes, whole grain cereals and fibre in the diet, increase their availability, accessibility and promote their consumption
5) Improve the public's ability to make informed decisions about a proper diet through useful, easy to understand labelling and to promote nutrition and health literacy
6) Promote and protect exclusive breastfeeding in the new born for the first 6 months and promote complementary adequate feeding after this age
7) Reduce consumption of sugars and other caloric sweeteners added to foods, increase food availability and accessibility of low- or no-added caloric sweeteners
8) Decrease daily consumption of saturated fats in the diet and minimize consumption of trans fats from commercial sources
9) Inform the public about controlling recommended portion sizes in the home preparation of foods, being accessible in permitted processed foods and include restaurants and food outlets in offering small portion sizes
10) Reduce daily sodium intake and increase the availability and accessibility of low- or no-sodium products.

As the reduction of sugar, fat and sodium in beverages were among the actions tools recommended, this has helped to create a number of *Normas Oficiales Mexicanas* (NOMs) (translated into English as 'Official Norms' that have high political force) to regulate sugar and sodium in beverages in federal meals, promote safe drinking water, food labelling and regulation of food advertising (Moise et al., 2011)

2.4.1 School policies

As part of the ANSA initiative, the Ministry of Education published guidelines for the sale and distribution of food and beverages in basic education establishments (preschool, primary education, which is from year 1 to year 6, and secondary education, which is from year 7 to year 9). These guidelines were implemented nationwide on January 1st, 2011. The guidelines provided a list of permitted and prohibited beverages (Table 2.5) and described the methods for monitoring and evaluating the policy. According to this guidance, any foods or beverages sold in schools must be preauthorised by the school principal and by a committee of parents. The agreement also stipulated that schools must promote the intake of plain water by assuring its availability in the school premises. Also, marketing of beverages other than water was banned.

Table 2.5 Beverages permitted in all basic education establishments in Mexico in 2011

Beverage permitted
• **Plain milk and milk beverages with non-caloric sweeteners** (only permitted for secondary school) in portion <250 ml. Energy ≥50kcal/100ml • **100% fruit juice** in portion of<200 ml in Stage I and II and < 125ml in Stage III. Energy <110 kcal/serving in Stage I and II and <70kcal/serving in Stage III<110 kcal • **Nectars** in portion of <200 ml Stage I and II and < 125ml in Stage III. Energy < 110 kcal/serving in Stage I and II and <70kcal/serving in Stage III • **Soy-based beverages** in portion of <200 ml (stage I and II) and < 125ml in Stage III. Energy <60 kcal/serving in Stage I and II and <40kcal/serving in Stage III

The implementation of the policy was divided in two stages, in order to give the food industry time to modify or reformulate the nutritional content of foods and beverages. These modifications included: 1) the reduction of portion sizes; 2) the use of different ingredients in order to assure the cut-off points for total fat and sugar in all products, 2) the total fat, saturated fat and sodium in prepared food and snacks; 3) the total fat, saturated fat, added sugars and sodium in confectionery and 4) the calorie content per serving of fruit, vegetables and nectar juices and soy-based beverages. In 2014, school nutrition policies were modified and extended to all high schools and universities in Mexico. Modification included that sales of any processed foods and beverages were only allowed on Fridays, in 250ml portions, provide 10 kcal/portion, 55mg sodium/portion, 100mg of non-caloric sweeteners and had no caffeine and no taurine (Secretaria de Gobernacion, 2014).

There is limited evidence available regarding the evaluation of these school policies. One recent cross-sectional study in a nationally representative sample evaluated the effects of Stage II (2011-2012) and Stage III (2012-2013) guideline implementation in primary schools. Results indicated that energy intake and macronutrients from foods purchased at school were lower than the ANSA recommendations, indicating that school policies might be helping to improve dietary intake (López-Olmedo et al., 2018a). However, a slight increase in energy intake was observed between the guideline implementation stages (Stage II 239 kcal; 95% CI: 180.5, 298.2 vs. Stage III 289 kcal; 95% CI: 236,5, 342,8). Also, a decrease in sugars was observed between stages (Stage II 18.7 g; 95% CI: 14.1, 23.3 vs. Stage III 16.9 g; 95% CI: 12.5, 21.3) (López-Olmedo et al., 2018a). This evaluation is the first published, so clearly more research is needed to see if the same patterns are observed in adolescents and young adults (secondary school, high school and universities), as well as between private and public schools.

2.4.2 Taxation of SSBs

Fiscal policies have been used as a means to promote reductions in the consumption of added sugars in different countries. The first countries that implemented a tax on soda were Norway and Samoa in the 1980s, however tax implementation has become more common around the world since 2011, with 20 countries (including Mexico) and various cities or counties in the U.S. having implemented some type of fiscal policy to reduce SSBs to date (Smith et al., 2018).

The aim of taxing SSBs in Mexico is to promote the reduction in caloric intake and therefore prevent population weight gain and subsequently prevent obesity and diabetes (Barrientos-Gutierrez et al., 2017). In September 2013, the Mexican congress passed a specific excise tax on SSBs to distributors. An excise tax is defined as a fixed dollar amount dependent on the volume of the beverage (World Cancer Reserach Fund International, 2018). The specific excise tax took effect on 1st January 2014 and consisted of an increase of 1 peso per litre (£0.04) (representing approximately a 10% price increase) for any bottled or powdered non-dairy and non-alcoholic beverage with added sugars (Rivera, 2016).

As the SSB tax is applied to distributors the tax is expected to be reflected in the price. Moreover, evidence suggests that the tax passed on to consumers in urban areas as prices increased close to one peso per litre (range 0.90-1.05 pesos) (Colchero et al., 2015). However, the tax was not passed on to consumers equally across urban areas in Mexico and by package size. For instance, there was overshifting in Mexico City, Central North, North Border and Northwest regions but undershifting in the Central South, Northeast and South regions (Colchero et al., 2015). In terms of package size, small beverage packages (<600 ml) increased in price (1.50 pesos) more than beverages in larger packages (>1litre, 1.08 peso), which according to Colchero et al. (2015), reflects the industry’s attempts to prevent discouraging consumers from buying larger packages, which are affected by taxation the most.

A longitudinal study in rural areas, conducted between December 2013 and December 2014, concluded that an increase of 1 peso per litre was observed between December 2013 and April 2014, however by December 2014 the tax was reduced to 0.70 cents per litre, suggesting that the tax was not fully passed on to the consumer. There was also heterogeneity in prices and this dependent on the type of beverage, portion sizes and the place of purchase. For instance, an increase in price was observed in all bottled SSBs except for energy drinks. Similar to what was observed in urban areas, a higher increase in price was observed for SSBs sold in containers less than 600 ml (1.6 pesos in April 2014 and 0.60 in December 2014), whereas for SSBs of 600 ml or more, the increase in price was lower (0.76 in April 2014 and 0.90 in December 2014) (Colchero et al., 2017c).

Preliminary data from the evaluation suggests that there has been an impact of the tax on SSB purchases and sales at the population level. A study using longitudinal data from a consumer panel of 6,645 Mexican households in urban areas suggested that the average purchases of SSBs declined by 7.6% two years after the tax implementation (2014 and 2015). The decline was larger during the second year (9.7% compared to 5.5% in the first year) (Colchero et al., 2017b).

Likewise, a decrease of 7.3% in sales was observed two years after the tax was implemented, when adjusted by seasonality and economic activity (Colchero et al., 2016). Another study using four rounds of the National Income and Expenditure Survey concluded that the probability of purchasing SSBs (the SSB definition included non-caloric SSBs) decreased by 2.3% in 2014 compared with the previous rounds (2008-2012). Moreover, a reduction of 6.3% in the purchase of SSBs was observed and this reduction was higher among lower income households (-10.3%), urban residents (-3.9%) and households with children (-11%), compared to adult only households (-2.4%) (Colchero et al., 2017a). While all households showed a decline in purchases of taxed beverages, low SES households presented the largest average decline of 11.7% in both years, compared to 5.1% in the high SES group (Colchero et al., 2017b), indicating that the tax is regressive and therefore targeting the group with the lowest prevalence of obesity (see section 1.3.1.1).

Due to a lack of availability of dietary data post taxation, it has not been possible to examine changes on the actual intake of SSBs. However, a recent study using the average tax effect on pre-tax intake of SSBs, suggested that SSB intake is expected to be reduced by 22 ml/person/day, which translates into 8.3 kcal/person /day (Sánchez-Romero et al., 2016). In terms of BMI, the projected reduction for a period of 10 years for the overall adult population with overweight (28.40 kg/m^2) was 0.15 kg/m^2. The projected BMI reductions varied depending on SES and age. For instance, low-SES participants and younger adults (20-39 years) showed larger BMI reductions than the other SES levels and age categories, with 0.37 kg/m^2 for low SES and 0.18 kg/m^2 for young adults. Also, those who consume higher amounts of SSBs (fourth quartile) are expected to have a higher reduction of SSB intake than those in the first quartile (0.45 kg/m^2 and 0.84 kg/m^2 for the average and peak monthly effects). Overall, the simulation models indicate that if the tax rate of 10% is maintained, obesity would decrease by 2.54%, whereas overweight and normal weight would increase by 0.51% and 2.25%, respectively (Sánchez-Romero et al., 2016).

2.5 Discussion of the literature

The high intake of SSBs is a significant issue affecting the Mexican population. Evidence has shown that the high intake of SSBs is contributing to increases in obesity and the risk of metabolic syndrome and hyperuricemia, which are well known risk factors for cardiovascular disease, diabetes and premature death in adulthood. Obesity, in relation to SSB intake, has been the most investigated health risk factor in Mexico. The evidence showed consistent results across studies, indicating that SSB intake is positively associated with weight gain. Therefore, the current evidence provides a good rationale to investigate the intake of SSBs in more detail, as this will guide the design of SSB reduction strategies in the Mexican population, which in turn would help to prevent the incidence of these health risks.

Several theoretical models have been used to explain the intake of SSBs in adults and children. However, most of the studies have used cognitive (individual) models (i.e. TPB), whereas fewer studies have used more comprehensive model models like the EnRG framework. Considering the limited explicative power that cognitive models have on SSB intake, the use of ecological models could better account for the interaction between individual and physical, social, and policy environments that are relevant in the intake of SSBs. Therefore, examining the intake of SSB using a socioecological model could provide a more comprehensive picture of this phenomenon and therefore prove a better tool for the design of different multi-level intervention to reduce intake in Mexican population.

Despite the high intake of SSBs in Mexico, less is known about the factors that influence the intake of SSBs among the Mexican population. To the best of my knowledge, no study conducted in Mexico to date has examined the role of individual, social and meso- and macro level factors in the intake of SSBs. While international evidence on the determinants of SSB intake is abundant, this type of research has only been conducted in developed countries, and therefore has a very limited generalisability to the Mexican context. For instance, it could be that factors that have been investigated in European countries might not be relevant in the Mexican context. However, research conducted in other countries can guide the initial research on the determinants of SSB intake in Mexico, which is in line with the objectives of this thesis.

Very little is also known about the role of the home and school environments in the intake of SSBs in Mexico, especially after the implementation of the policies discussed previously. Therefore, a detailed exploration of how these environments are promoting the intake of SSBs is important, as it would provide invaluable insights into the potential barriers of current policies, as well as the potential areas that render improvement.

Policy adoption in Mexico, including the taxation of SSBs, appears to be a factor that could trigger reductions in SSB intake. Although the short-term evaluation of the taxation has been positive, several questions of these policies' effectiveness remain. Firstly, no evidence is available to support changes in the intake of SSBs, as all that is known is the 2-year effect of the tax on household purchases and sales of SSBs (not individual consumption). This can only lead to assumptions about the effect of taxation on individual intake. Second, current evidence does not permit the assessment of which members of the household have been affected by the tax the most, or whether people purchase and consume SSBs outside the household, or about potential substitution patterns. It could be that the decline in purchases is compensated for by the preparation of home-made SSBs, like *aguas frescas*. Finally, less is known about how people perceive the tax and how that has influenced their beverage choices.

From a methodological perspective, the majority of studies have focussed on the relationship between different factors and SSB intake. However, the distribution of SSB intake tends to be highly skewed toward the left, which is why many studies transform SSB intake into means to guarantee normality (Hearst et al., 2009; Tak et al., 2011; Vågstrand et al., 2009; Van Lippevelde et al., 2013). This has important implications for the understanding of the relationship between different determinants and SSB intake. For example, it is unlikely that the mean relationship between a given factor and SSB intake is sufficient or adequate to explain the very high or very low intake of SSBs. That is, if the coefficients from a regression model do not explain high intake, that means that the most relevant population group is underexplained. This raises the questions about whether and how the relationship between the different factors (sociodemographic, individual, social, environmental) and SSB intake varies across diverse points of the distribution (low vs. high intake). Different statistical approaches are therefore needed to model this accordingly.

2.5.1 Research questions

This thesis aims to bridge the aforementioned gaps in the evidence base by focussing on the following research questions (RQ):

RQ1: What is the association between sociodemographic factors and different classes of SSB consumers in Mexico using a representative sample of the population?

> **RQ 1.1:** What is the number of classes of SSB consumers in a sample of the Mexican population?
>
> **RQ 1.2:** What are the types of SSBs consumed by each class?
>
> **RQ1.3:** What is the sociodemographic profile (age, gender, SES, region, area of residence) of different classes of SSB consumers?

RQ 2: Is there an association between individual, social, and micro-environmental factors and SSB intake in a sample of Mexican adolescents?

> **RQ 2.1:** Does the association between different factors vary depending on the amount of SSBs consumed?

RQ 3: Are individual level theories (TPB and habit theory) useful to explain SSB intake in a sample of Mexican adolescents?

RQ 4: What are adolescents' perceptions on how the home environment might play a role in the intake of SSBs in the homes?

> **RQ 4.1:** What are adolescents' perception on the availability of SSB in their homes?
>
> **RQ 4.2:** Are there other factors within the home environments that are promoting SSB intake among Mexican adolescents?

RQ 4.3: What are the potential contextual cues in the home environment that trigger SSB intake among a sample of Mexican adolescents?

RQ 5: What are adolescents' perceptions on how the out-of-home environment might play a role in their intake of SSBs?

RQ 5.1: What are adolescents' perceptions on drinking SSB their schools and in other out-of-home activities?

RQ 5.2: What are the potential contextual cues in the out-of-home environment that trigger SSB intake among a sample of Mexican adolescents?

RQ 6: What are adolescents' perceptions and awareness of current SSB tax?

RQ 6.1: How have taxations affected adolescents' purchase and intake of SSB?

RQ 6.2: What are adolescents' perceptions on the substitution of SSBs with other beverages?

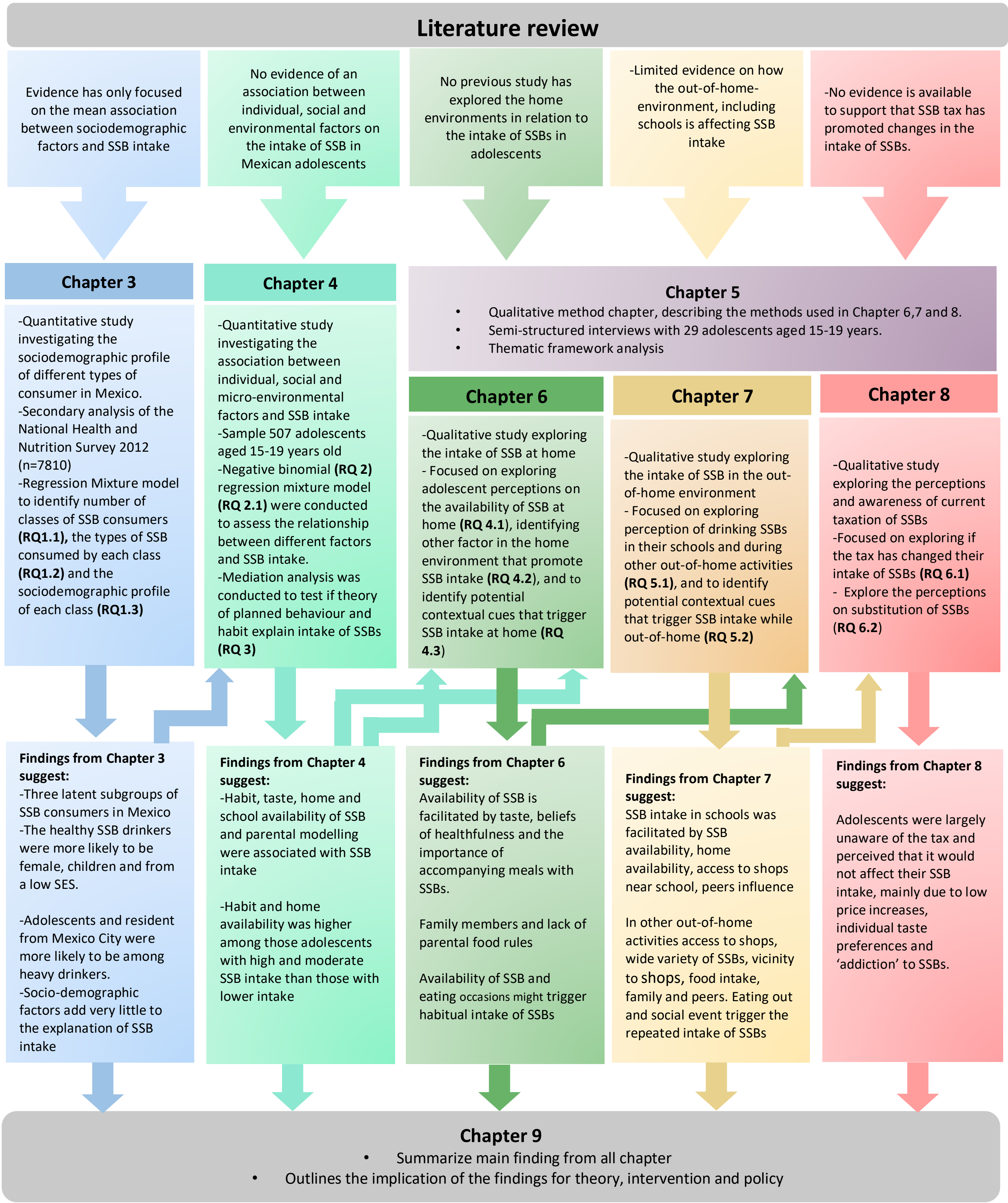
2.6 Structure of the thesis

This section provides an overview of the structure of the thesis by outlining the studies conducted to address each of the research questions. **Figure 2.6** shows the rationale from each of the empirical chapters and how all the chapters fit together. Chapters 3 and 4 are quantitative chapters, and each one includes methods, results and chapter-specific discussion. Chapter 5 describes the qualitative methods used for the studies presented in Chapters 6, 7 and 8; for each of these chapters results and chapter-specific discussion are presented. Chapter 9 is an overall discussion of the thesis' findings (from all five studies). This chapter also discusses the research and policy implications of the results, the strengths and limitations of the thesis, as well as an overall conclusion.

2.7 Researcher's role

All the work presented in this thesis is an independent piece of research and the PhD candidate was responsible for every stage of the investigation. This included obtaining ethical approval (details can be found in Appendix 1), data collection, data management (including cleaning the quantitative data set as well as verbatim transcribing the qualitative interviews), analysis and writing-up of the results. Analysis of the qualitative data was assisted by an independent second coder.

Figure 2.6 Structure of the thesis



Chapter 3 Study 1: Classification of sugar-sweetened beverages consumers in Mexico

3.1 Chapter overview

Chapter 1 introduced the obesity epidemic as a public health concern in Mexico and outlined its relationship with SSBs intake (Cantoral et al., 2015; Caravali-Meza et al., 2016; Jimenez-Aguilar et al., 2009; Stern et al., 2017). Chapter 2 reviewed the evidence on SSB determinants and policies concluding that the empirical agenda is fairly new in Mexico and research relying on behavioural theories is vital to further advance the knowledge and the capacity of policies to tackle SSB intake.

The emerging empirical research on SSBs in Mexico is rather descriptive and has not fully exploited the existent data. The existent studies have focused on variations in average intake across socio-demographic groups without paying much attention to the other potential factors that could explain such differences in SSB intake. Barquera et al. (2008) and Barquera et al. (2010a) first published caloric beverage patterns for children, adolescents and adults using the Mexican Health and Nutrition Survey 2006 (ENSANUT). Results reported the per capita and per consumer caloric intake and mean intake in ml/day. The intake of caloric beverages was described by SES, country region, urban vs. rural and gender for pre-school children, school- aged children and adults but not for adolescents (described in section 2.3.1.1). Around the same time, Jimenez-Aguilar et al. (2009) also using the ENSANUT 2006, reported the number of SSB servings consumed by adolescents according to gender, age, menarche, BMI, SES, region, area (rural/urban) and TV watching (hrs/week), and assessed the association between BMI and SSB intake (described in section 2.3.1.1).

Recent analyses of ENSANUT 2012 reported average per capita and per consumer intake of caloric and non-caloric beverages as well as energy intake from these beverages (see section 1.4.1), however no associations with sociodemographic characteristics were assessed (Stern et al., 2014). A later study by Aburto et al. (2016) using the same data set applied multiple linear regression to assess the association between total dietary energy intake from SSB of the Mexican population and age, gender, region and area of residence (urban/rural). As described in Chapter 2 (section 2.3.1.1), findings from this study suggested that adults had higher total energy intake from SSB than children and adolescents (β=-3.6%; $p<0.01$ and -1.1%; $p<0.01$ respectively), females showed lower percentage contribution of SSB to total energy intake (β=-1.7; $p<0.01$) than males. Those residing in urban areas and in the north region presented had higher percentage contribution of SSBs to total energy intake than those residing in rural areas (β=-1.5; $p<0.01$) and in the central (β=-3.0; $p<0.01$) and south regions (β=-2.5; $p<0.01$). No difference in the total energy intake contribution of SSBs by SES in the whole Mexican population (Aburto et al., 2016).

Although this research has helped to enhance the understanding of the distribution of SSB intake across population groups in Mexico, a key limitation of the current evidence is that it has oversimplified the relationship between SSB intake and some of its predictors. Existing research has focused exclusively on average SSB intake, which prevents us from knowing what explains the very high or low consumption of SSBs among certain population groups and hinders the development of targeted interventions that prioritize critical subgroups (Etilé and Sharma, 2015). Previous studies have focus on average intake because they ignored the non-normal distribution of SSB intake – highly skewed toward zero and only a few individuals consume high amounts of SSBs. This has led to a narrow empirical agenda were only mean relationships between the response variable and the explanatory variable are explored. This practice seems to be at odds with contemporary applied research which has shown that non-normally distributed variables are hidden mixture of distributions that capture by the existence of different subpopulations or classes, which in this case would mean low, medium and high SSB consumers (Wang and Wang, 2012). Therefore, by reporting on the ‘average’ consumer, the complexity of SSB intake is not only inadequately modelled but lost.

The limitations in current research have important implications for policies and the understanding of SSB intake. First, changes in key variables such as prices, socio-economic, demographic, behavioural and environmental factors might affect high consumers in a different way than to low consumers. If tax policies, for example, aim to tackle the severe cases of SSB intake (i.e. very high consumers), it is uncertain whether this group of high SSB consumers would reduce their consumption due to an increase in prices or whether the elasticity (changes in the demanded quantity of a product following price changes) for this group is zero. Second, socio-economic factors might have a different role depending on the amount of SSBs an individual is consuming, as previous evidence has suggested that medium-high SES may consume more SSB than low SES (Jimenez-Aguilar et al., 2009). Finally, common statistical techniques such as linear regression, which focus on average intakes, cannot account properly for the variation caused by high consumers (i.e. those at the end of the intake distribution) (Etilé and Sharma, 2015). Therefore, a more comprehensive empirical approach is required to understand these specific aspects of SSB consumption and its predictors.

This chapter first presents the aims and research questions of the current study (Section 3.1.1). Second, it describes the methods, including data collection procedures and the assessment of the variables of interest (Section 3.2.1 and 3.2.2). This is followed by the description of the statistical analysis (finite mixture models) and model building process (section 3.2.3). Third, it presents the findings (Section 3.3). Finally, the discussion (Section 3.4) and thesis implication (Section 3.5).

3.1.1 Aim and Research questions

The aim of this chapter is to analyse further the data that empirical research in Mexico has used to understand SSB intake and assess the extent to which current data is sufficient to produce a comprehensive explanation of this phenomenon. Hence, the aim of this study is threefold. First, to use the ENSANUT 2012 to explore whether there are latent sub-groups of individuals with clear differences in SSB intake and its sociodemographic predictors. Second, to assess the extent to which the available data helps to understand SSB intake in Mexico. Third, to draw some of the research challenges that emerge from current data in order to build up and frame the remaining questions of this thesis. This study will answer research question 1 of this thesis:

RQ1: What is the association between sociodemographic factors and different classes of SSB consumers in Mexico using a representative sample of the population?

> **RQ1.1:** What is the number of classes of SSB consumers in a sample of the Mexican population?
> **RQ1.2:** What are the types of SSBs consumed by each class?
> **RQ1.3:** What is the sociodemographic profile (age, gender, SES, region, area of residence) of different classes of SSB consumers?

3.2 Methods

The data used for the current study were collected as part of the Mexican Health and Nutrition Survey (ENSANUT 2012).The ENSANUT 2012 is a nationally representative (32 states and four regions), probabilistic, cross-sectional, multistage, stratified survey with sampling power to disaggregate by rural (population <2500 inhabitants) and urban (population > 2500 inhabitants) areas and by four geographic regions: i) North (Baja California, Baja California Sur, Coahuila, Chihuahua, Durango, Nuevo León, Sonora and Tamaulipas); ii) central (Aguascalientes, Colima, Estado de México, Guanajuato, Jalisco, Michoacán, Morelos, Nayarit, Querétaro, San Luis Potosí, Sinaloa and Zacatecas); iii) Mexico City; and iv) South (Campeche, Chiapas, Guerrero, Hidalgo, Oaxaca, Puebla, Quintana Roo, Tabasco, Tlaxcala, Veracruz and Yucatán).

Data was collected between October 2011 and May 2012. The data collection process was divided in three phase: 1) identification of households; 2) application of household and individual questionnaires; and 3) anthropometric measurement and application of dietary questionnaires (Denova-Gutiérrez et al., 2016a) Information of 50,528 household and 96,031 individuals was obtained by different age groups (Romero-Martínez et al., 2013). Among the objectives of this survey was to characterize the health and nutritional status of the Mexican population. Data was collected according to the Declaration of Helsinki and the survey was approved by the Ethics Committee of the Mexican National Institute of Public Health (Romero-Martínez et al., 2017).

3.2.1 Dietary assessment

There are different self-reported dietary assessment methods to measure diet such as food diaries, 24-hour recalls (24HRs) and food frequency questionnaires (FFQ). Food records or diaries are self-report accounts of all food and beverages consumed over one or more days where respondents are requested to record all food and beverages consumed (National Cancer Institute, 2018). Food records collect very detailed information about the food and beverages consumed, such as time of consumption, brand names, preparation method and portion sizes (Medical Research Council, 2018). Some of the limitations of food diaries are that they are time consuming, they rely on some level of literacy of the respondent, as they have to hand-write the food items consumed, and they are expensive and time consuming to code. Finally, in order to account for day to day variation in dietary intake (i.e. weekday/weekend), it is commonly required to keep a record of foods and beverages consumed over two or more days, which can be burdensome to participants as participants would need to write what they consumed as they consumed it or recall what they ate for several days (National Cancer Institute, 2018).

A 24-hour recall (24HR) is a structured interview intended to capture all foods consumed by the respondents in the past 24 hours (National Cancer Institute, 2018). A 24HR can identify average consumption and provide accurate measures of dietary intake, as it captures details about preparation methods, food components and amounts consumed (Hill et al., 2017; Hughes et al., 2017; Medical Research Council, 2018). Among the limitations of 24HRs are that they are time-consuming as ideally two or more non-consecutive 24HRs (i.e. weekday/weekend) are needed to account for day-to-day individual variability, which increases the cost of application (Medical Research Council, 2018; National Cancer Institute, 2018).

A quantitative FFQ is a list of foods and beverages with two response categories, one that indicates frequency of intake over a certain period of time (i.e. a week, a month) and the other indicating portion size (National Cancer Institute, 2018). FFQs are designed to capture habitual intake and can be designed to assess the intake of specific nutrients or food groups and tend to be easy and low cost to apply (Medical Research Council, 2018; National Cancer Institute, 2018). Among the limitations of FFQs are that they do not record any detailed information about food preparation, brands and contextual information. Moreover, because an FFQ uses a pre-specified food list, not all FFQs reflect the food and beverages consumed of a given population (National Cancer Institute, 2018). Both the FFQ and the 24HR are retrospective dietary assessments which can introduce recall bias as participant would need to recall what they have eaten in the last day or in prolonged period of time (a week or a month) (Naska et al., 2017).

The ENSANUT 2012 collected dietary information through an electronic semi-quantitative food frequency questionnaire (SFFQ) and 24HR. The SFFQ assessed the frequency (numbers of days and number of times a per day ranging from never to six times a day) and standard portions sizes consumed of 140 food items in the last seven days prior to the interview (Denova-Gutiérrez et al., 2016a). The SFFQ was randomly applied to a subsample of individuals from the 50 528 households. The subsample was made up of one out every six individuals per age group (Ramírez-Silva et al., 2016). A total of 7,810 individuals completed the SFFQ from which 1,338 were pre-school children (0-4 year), 1,392 school children (5-11 year), 2,203 adolescents (12-19 year) and 2,879 adults (≥60 years). For the present study, eight types of SSBs assessed using the SFFQ were included in the analysis: soda (carbonated drinks), sweetened coffee and tea, flavoured drinks, 100% fruit juices with added sugar, industrialized juices, aguas frescas and atole (water based). These last two are traditional beverages prepared with water, fruits or cereals and sugar; for the atole, corn flour and “piloncillo” (unrefined cane sugar) is added.

3.2.2 *Sociodemographic information*

Sociodemographic data were gender, age, region and SES. Age was grouped in three categories: children (1-11 years), adolescents (12-19 years) and adults (20-≥60 years). Region was disaggregated by four geographical regions as described earlier (North, Central, Mexico City and South). The SES index was constructed based on Living Condition Index. This index was first developed for the Mexican Household Income and Expenditure Survey (HIES) where a principal component analysis was used to construct the index based on goods and household characteristics. The scores obtained where classified in tertiles: low, middle and high SES.

3.2.3 *Statistical analysis*

Descriptive statistics were computed to describe participants' sociodemographic characteristics and SSB intake. Independent t-tests were used to assess the mean intake differences per each SSB by gender. To model SSB intake and its predictors this chapter relies in the latent variable approach framework. Specifically finite mixture modelling (FMM), which is a family of methods within structural equation modelling (SEM), was used to assess the non-normally distributed SSB intake and its relationship with the different socioeconomic and demographic variables (Wang and Wang, 2012).

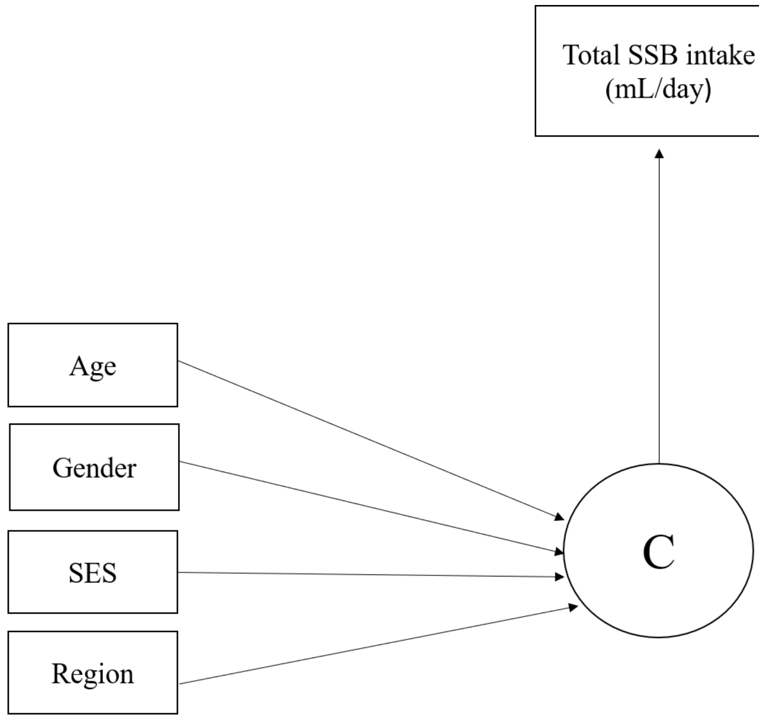
FMM was chosen instead of standard cluster analysis techniques (i.e. K-means or hierarchical clustering) because it offers a model-based approach that derives clusters or classes using a probabilistic model (Vermunt and Magidson, 2002). Therefore, as a model-based approach FMM permit to select a model and assess it goodness of fit, something that it is not possible with cluster analysis (Vermunt and Magidson, 2002). Finally, cluster analysis does not permit the inclusion of covariates that predict individuals latent class membership (Kaufman and Rousseeuw, 2009).

The main assumption of FFM is that a given distribution is a product of unobserved/latent distributions or mixtures (Wang and Wang, 2012). That is, SSB follows such a distribution due to existence of hidden subgroups/classes. There are various kinds of FFM that could be suitable to explore class membership and its predictors. Latent Profile Analysis (LPA), for example, uses observed continuous indicators to identify the number of latent sub-groups and estimates the mean consumption within class for each beverage (Williams and Kibowski, 2016). LPA with auxiliary variables (socio-demographic variables) would have been ideal to draw the classes and assess the within-class mean consumption for each beverage with different socio-demographic and economic factors. However, the nature of the data affected the capacity of LPA for producing meaningful groups. The variable "soda (ml/day)" captures a great deal of the variability of total SSBs (around 75%) and the LPA tries to accommodate the classes based on the mean soda intake (i.e. both soda drinkers and non-drinkers) with both free and equal within-class variances, where the consumption of other beverages is disregarded (see graph in Appendix 2). Although these two groups are relevant, the LPA results are too restrictive for the purposes of this chapter, i.e. a class comprising of around 90% of the population that tells little about the different kinds of consumers. Thus, given that LPA did not fit the data as expected, an alternative analysis within the finite mixture models was chosen, namely regression mixture model (RMM). Like LPA, RMM assumes that a series of latent groups cause certain levels and patterns of intake of SSBs. However, the main difference between these two approaches is the type of variable utilized to draw the classes. LPA uses series of continuous indicators (intake in ml of each SSB), whereas RMM uses one continuous distribution (total intake in ml of SSBs), where latent classes are drawn from sub-distributions (mixtures) of the total SSB intake (Kim et al., 2015; Van Horn et al., 2009). In a second step is possible to estimate the mean intake by beverage within class as in the standard LPA. On this basis, RMM is likely to be less affected by the large overlap between intake of soda and the rest of the variables. Therefore, a conditional RMM was estimated using gender, age, region and SES as covariates.

3.2.3.1 Model-building process for RMM

Mixture modelling approaches use a series of steps and statistics to decide the optimal model, i.e. the model that best fits the data. First, they determine the optimal number of latent classes (clustering), by estimating a series of models with increasing numbers of classes. The solutions are compared using specific model fit statistics, namely Bayesian information criteria (BIC) and the sample-size adjusted criterion (SABIC), as these have shown to be effective in latent-class enumeration in RMM (Kim et al., 2015; Van Horn et al., 2009). Although there are other statistics that aid class enumeration, such as the Akaike's information criterion (AIC), the Lo-Mendell-Rubin likelihood ratio (LMR) and the Bootstrap Likelihood Ratio Test (BLRT), these were not considered for class enumeration in this study because both AIC and LMR overestimate the number of classes (Kim et al., 2015; Nylund et al., 2007), and BLRT cannot be used with complex sampling frameworks. The basic idea of information measures is to compare the plausibility of different models. Smaller values of the statistic indicate a better the fit of the model, this relates to the association between the number of parameter included in the model and the decreased in deviance (Williams, 2017). Therefore, the best model was selected based on the smallest BIC and SABIC. Then, the quality of the classification (class membership, i.e. the probability that participants belong to one of the classes) was assessed by the entropy statistic of each model. Entropy value range between 0 and 1. The larger the entropy, that is values approaching 1, indicate clear separation of classes (Asparouhov and Muthen, 2014a). Second, because the objective of the present study was to assess the sociodemographic profile of each class of SSB consumers, these variables were then brought into the model as covariates, also referred to as predictors of the latent classes (Figure 3.1).

Figure 3.1 Path diagram of the regression mixture model with sociodemographic variables predicting class membership (the probability of an individual to be assigned to a specific latent class)



3.2.3.2 Covariates inclusion

Statistical theory has suggested several approaches to include covariates into the model (Asparouhov and Muthen, 2014b). As seen in Figure 3.1 the covariates included in model were age, gender, SES, region and percentage of total energy intake from SSBs. It was of interest to assess if individuals' body mass index (BMI) differed across classes. However, when introducing BMI as a categorical variable in the model (i.e. underweight to obese) a high correlation between age (also categorical variable) and BMI affected the model results, due to BMI increases with age. It was also not appropriate to include BMI as continuous variable, as BMI was reported as z-scores for participants under 18 years old and as a continuous variable for adults BMI. However, separated RMM analysis were conducted including BMI as covariate in separate models for children (z-BMI), adolescents and adults (BMI). Results showed no association between BMI and class membership (result are not showed).

The most common approaches to include covariates in the model are the 1-step-approach, where class enumeration and inclusion of covariates is done in one single step, and the 3-step approach (Asparouhov and Muthen, 2013). The latter involves performing the enumeration of classes first, followed by creating the most likely class variable using the latent class posterior distribution (obtained during the first step), and then regressing the most likely class on predictor variables (Asparouhov and Muthen, 2013). In the 3-step approach, sociodemographic variables were included in the model as auxiliary variables, which indicate the model to assess the association between sociodemographic factors and class membership (the probability of an individual to be assigned to a specific latent class). For this study, inclusion of covariates was performed using both approaches with different parameter contains (free and equal variance) this to allow different class variances. Because the stability of each approach is data-dependent, results were then compared to assess the consistency of the estimates across models. Because results from both approaches were very similar (Appendix 3), only results of the 3-step approach are presented below. All models accounted for the complex design of the survey (strata, clusters and sampling weights). An alternative model were run adjusting for the percentage of total energy intake to see if the this affected classification of SSB consumer. Data preparation and descriptive statistics were carried out using Stata 14 (Statacorp, College 82 Station, TX). Mixture model's analyses were performed using Mplus version 8 (Muthén and Muthén, 2017).

3.3 Results

A summary of the participant characteristics is shown in Table 3.1. There was an approximate even split across genders with good representation of children and adolescents.

Table 3.1 Sociodemographic characteristics of the sample with complete SSB data

	n (%)
Total population	7 810
Gender	
Male	3606 (46)
Female	4204 (54)
Age Groups	
Children (1-11y)	2550 (32)
Adolescents (12-19y)	2289 (29)
Adults (20- ≥60y)	2971 (38)
Socio-economic status	
Low	2873 (37)
Middle	2601 (33)
High	2336 (30)
Body Mass Index	
Underweight	30 (0.4)
Normal	4048 (55)
Overweight	1863 (25)
Obese	1451 (19)
Area	
Urban	4941 (63)
Rural	2869 (37)
Geographic Region	
North	1804 (23)
Central	2794 (36)
Mexico City	464 (6)
South	2751 (35)

Mean SSB intake by age group is presented in Table 3.2. Soda intake was the highest among all SSBs in all age groups. This was followed by aguas frescas and industrialized juices in children and adolescents and aguas frescas and atole in adults. Sweetened tea and coffee were the least consumed SSBs in all age groups.

Table 3.2 Mean daily intake of sugar-sweetened beverages by age group and by gender

	All		Males [a]		Females [a]		
SSBs (ml/day)	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**P [b]**
Children (n= 2,550)							
Soda	89.0	127.2	84.3	119.0	67.0	105.6	<0.001
Coffee w/sugar	2.3	4.9	2.3	4.8	2.1	4.7	0.30
Tea w/sugar	0.8	2.9	0.8	3.0	0.8	2.6	0.68
100% fruit juice w/sugar	8.5	48.9	7.1	35.7	5.6	36.5	0.27
Agua fresca	76.9	166.7	64.1	144.3	59.0	138.1	0.36
Flavoured drinks	19.7	60.8	20.1	62.4	18.3	59.5	0.45
Industrialized juices	28.6	61.4	28.9	63.3	27.5	57.3	0.53
Atole	20.4	62.3	20.2	63.5	18.1	55.5	0.36
Total	237.8	241.0	221.1	226.2	193.0	202.5	0.001
Adolescents (n=2,286)							
Soda	235.5	288.1	270.1	308.8	206.4	266.6	<0.001
Coffee w/sugar	7.8	11.8	5.6	9.6	5.1	9.1	0.16
Tea w/sugar	5.3	9.4	0.8	2.8	1.0	3.4	0.14
100% fruit juice w/sugar	0.9	3.2	9.6	51.0	9.4	42.2	0.92
Agua fresca	9.1	44.8	90.2	210.6	95.0	205.5	0.58
Flavoured drinks	22.6	80.9	26.6	89.6	20.9	76.2	0.10
Industrialized juices	33.5	76.0	30.6	68.2	33.3	77.6	0.36
Atole	20.2	63.4	18.1	60.0	22.8	66.5	0.07
Total	418.6	393.4	442.3	394.4	384.7	366.5	<0.001
Adults (n=2,971)							
Soda	216.7	290.5	258.3	317.1	167.6	247.6	<0.001
Coffee w/sugar	7.8	11.8	7.8	11.7	7.5	11.4	0.47
Tea w/sugar	1.1	3.4	1.1	3.6	1.1	3.5	0.51
100% fruit juice w/sugar	6.2	45.9	6.2	42.7	6.7	46.2	0.76
Agua fresca	111.9	233.1	89.5	209.2	95.0	209.3	0.47
Flavoured drinks	10.8	63.6	15.4	72.8	11.6	67.5	0.14
Industrialized juices	13.3	46.4	13.9	48.7	10.7	39.7	0.36
Atole	25.1	73.4	24.8	79.6	24.4	68.0	0.87
Total	387.0	409.0	411.1	395.9	318.2	346.1	<0.001

SSB, sugar sweetened beverages; SD, standard deviation; [a] Differences between genders were examined using Independent samples t-test. [b] P-values at the level <0.05 were used to reject the null hypothesis, i.e. beverages mean between gender are the same

3.3.1 *Class selection*

As suggested by the literature (Asparouhov and Muthen, 2013) the decision on the number of classes was taken before the inclusion of covariates. This approach helps to better understand the interpretation and identification of the latent classes (Clark and Muthén, 2009) and facilitates further analyses by preventing changes in class enumeration every time a variable is included or excluded from the model (as happens in the 1-step approach) (Kim et al., 2016; Vermunt, 2010).

Six models were estimated, and the model fit statistics can be found in Table 3.3. Even though all models showed good entropy (i.e. good class classification), the 5-class model had the lowest BIC and SABIC. It is well known in the mixture model literature that the statistics of these models tend to favour models with more classes even though, in some cases, the models split a meaningful class into two unmeaningful classes. Therefore, the composition of the classes was analysed. One of the classes in the 5-class model was very small with only 33 individuals (less than 1% of the sample), thus by examining the other classes it was assumed that the 5-class model was dividing one of the classes in two. Then, the 4-class solution was considered, however the same pattern was observed where only 76 individuals (1%) were classified in this class. One assumption of mixture models is that errors within classes are normally distributed when this assumption is violated, i.e. when skewness of the residuals are present in one or more classes, it results in some bias in parameter estimates and the selection of additional classes (Van Horn 2012). Therefore, distribution of the residuals was checked and skewness of the residuals of all classes in the 4-class and 5-class models was found (Appendix 4).

Table 3.3 Model fit statistics for regression mixture model using the 3-step approach

Model	BIC	SABIC	Entropy
2-class-RMM	112451.1	112438.4	0.92
3-class-RMM	111770.2	111751.1	0.87
4-class-RMM	110764.6	110739.2	0.90
5-class-RMM	110346.1	110314.3	0.91
6-class-RMM	110364.0	110325.9	0.92

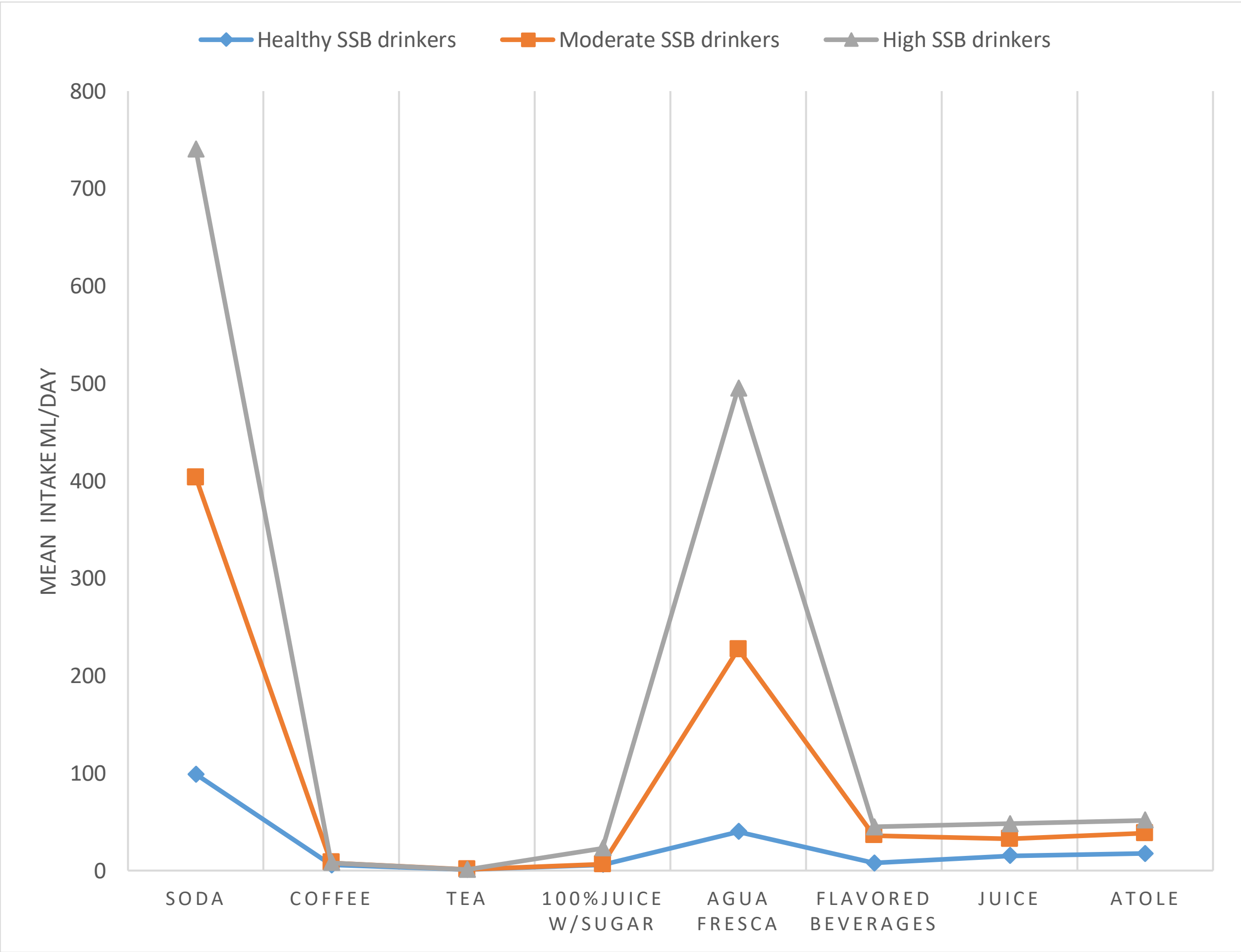
BIC= Bayesian information criteria; SABIC= Sample-size adjusted criterion

Due to this, the 3-class model was retained because the inspection of the residuals suggests that the smallest class in 5-class models was not meaningful. Class 5 and 4 showed similar characteristics, indicating that classes were being divided in two as a result of skewness of the residuals distribution for each class. The skewness of the residuals for the 3-class model indicates that the class-1 might be overestimated and perhaps class-2 underestimated. One possible factor that contributes to the skewness is the zero-intake population, which could be considered as a class in itself. However, the effects of residual skewness upon class identifications for models where the class solution is >2 are unknown and therefore the 3-class model was chosen, also based recommendations from experimental literature (Van Horn et al., 2012). Five additional model were run adjusting for % total energy intake from SSB, the model fit statistics suggest the selection of the 4-class model**.** However, the fourth class is so extreme that lead to very few people and inferential statistics are not feasible, i.e. the multinomial logistic model has to many empty cells that lead to very high odd ratios that are hard to interpret and not very useful from the conceptual point of view (see Appendix 5). Because the sociodemographic profile of SSB consumers does not change in the adjusted and unadjusted model the three-class model is presented below and the results are presented in Appendix 5.

The results are presented as follows. First the SSB intake patterns by class is presented and then this is followed by the sociodemographic profile for each class (Section 3.3.2 onwards). Three classes were defined: i) Class 1, labelled “healthy SSB drinkers”, as this group showed a relative low intake of SSBs compared to the other classes with an intake of 186.7ml/day. This group was the largest with 75% of the sample; ii) Class 2, the "moderate SSB drinkers", represented 18% of the sample with a mean intake of 719 ml/d of SSBs a day and; iii) Class 3, the "heavy SSB drinkers" represented the smallest group (7% of the sample), with a mean SSB intake of 1,378 ml/d (the highest across all three classes).

Intake patterns were similar across classes (Figure 3.2), where soda was the most consumed beverage by individuals in all four classes (C1=98.8ml; C2= 403.4ml; and C3=740 ml/day). This was followed by *aguas frescas* (C1=40ml; C2=227ml; and C3=468.2 ml/day). Among the less consumed SSBs were sweetened coffee, tea and sweetened 100% fruit juice, for which average intake was less than 10 ml/day, with the exception of individuals of Class 3 (heavy SSB drinkers), who consumed 23ml/day of sweetened 100% fruit juice.

Figure 3.2 Mean daily intake of each SSB by class



Error! Reference source not found. shows the results from the multinomial logistic regression assessing the association between different sociodemographic variables and class membership.

Table 3.4 Four-class multinomial logistic regression with the 3-step approach using healthy SSB drinkers as reference

Class	Moderate SSB drinkers			High SSB drinkers		
Proportion	18%			7%		
Parameter	OR [e]	95%CI	P value	OR [f]	95% CI	P value
Mean SSBs Intake (ml/day) per class	719.5			1378		
Gender[a]	0.66	[0.51, 0.85]	0.00	0.71	[0.48, 1.05]	0.10
Central[b]	1.15	[0.81, 1.64]	0.45	1.18	[0.77, 1.82]	0.45
Mexico City [b]	1.25	[0.78,1.99]	0.35	2.33	[1.27, 4.30]	0.01
South[b]	1.23	[0.88,1.72]	0.22	1.05	[0.66, 1.68]	0.84
Med SES[c]	1.49	[1.09, 2.04]	0.01	1.27	[0.83, 1.96]	0.28
High SES[c]	1.79	[1.28, 2.49]	<0.001	1.28	[0.82, 2.02]	0.29
Adolescents[d]	2.28	[1.68, 3.14]	<0.001	15.44	[5.81, 41.26]	<0.001
Adults[d]	1.17	[1.71, 3.20]	<0.001	12.81	[5.20, 31.55]	<0.001

[a] Reference is males; [b] reference is North; [c] reference is low SES; [d] reference is children; [e] odds are for class 2: Moderated SSB drinkers vs. class1: Healthy SSB drinkers for each of the reference groups listed above; [f] odds of class 3: High SSB drinkers vs. class 1: Healthy SSB drinkers for each of the reference group listed above.

3.3.2 *Sociodemographic profile of healthy SSB drinkers*

Females showed higher odds compared to males to be in the “healthy SSB drinkers” than in the “moderate SSB drinkers” class. However, when compared to the “heavy SSB drinkers”, both male and females showed equal odds to be in the healthy SSB drinkers class. Adolescents and adults were less likely (OR=0.07; 95% CI=0.02,0.17; p>0.001 and OR= 0.08; 95% CI= 0.03,0.19; p>0.001, respectively) compared to children to be in the “healthy SSB drinkers” than in the “heavy SSB drinkers” class (Table 1, Appendix 5). However, the odds increased when “healthy SSB drinkers” were compared to the “moderate SSB drinkers” class (OR=0.44; 95% CI= 0.32,0.60; p>0.001 for adolescents and OR=0.43; 95% CI=0.31,0.58; p>0.001), but low likelihood remained. Individuals in the low SES tertile were more likely to be in the ‘healthy SSB drinkers’ class than in

‘Moderate SSB drinkers’ class. All regions presented equal odds of being in the ‘Healthy SSB intake’ class compared to the moderate and high SSB drinkers’ classes (**Error! Reference source not found.**).

3.3.3 Sociodemographic profile of moderate SSB consumers

As shown in **Error! Reference source not found.** when compared to the healthy SSBs drinkers, females were less likely to be in the moderate SSB drinkers’ class than males. Both males and females showed equal odds of being in the moderate consumer class, compared to the high intake class (Table 2, Appendix 5). There was strong evidence of increased odds for adolescents (OR= 2.28; 95% CI: 1.68, 3.14; p <0.001) and adults (OR=1.17; 95% CI: 1.71, 3.20; p<0.001) to be in the moderate SSB drinkers group compared to the lower intake group. However, when compared to the high intake group, children showed almost seven times greater odds to be in the moderate consumer class than adolescents and adults. Individuals in the medium and high SES tertile, relative to individuals in the low SES tertile, were more likely to be in the moderate SSB consumer class than in the healthy SSB consumer group. However, when compared to the high intake class, all SES tertiles showed equal odds of being in the moderate intake class. Likewise, no regional differences were observed for the moderate SSB drinkers’ group when compared to the other classes

3.3.4 Sociodemographic profile of heavy SSB drinkers

In the high intake group, no differences in gender and SES were observed indicating that both females and males, as well as all SES tertiles, had equal odds of being in this group. When age groups were compared to the lower intake group, adolescents were fifteen times more likely to be classified in “heavy SSB drinkers” class than children and almost three times more likely than adults. Odds decreased slightly when compared to the “moderate SSB drinkers” but remained significant. Individuals residing in Mexico City relative to residents from the northern region, showed to be two times more likely to be in the high consumer group compared to the healthy SSB drinker class. Nonetheless, no evidence was found to support differences in any of the regions when comparing the moderate SSB drinkers and the heavy SSB drinkers’ classes (Appendix 3)

3.4 Discussion

This study sought to expand current knowledge on SSB intake and its predictors in Mexico, to assess the extent to which the available data provides a comprehensive explanation of variation in SSB intake and serve as a reference for further questions for the rest of the thesis. In particular, this study sought to investigate the sub-groups of SSB consumers in Mexico based on total intake of SSBs, using a nationally representative data set. Finite mixture models provided information about the profile of the three different subgroups of SSB consumers in Mexico: healthy SSB drinkers, moderate SSB drinkers and heavy SSB drinkers. In terms of sociodemographic factors, finding suggested that the likelihood of individual being categorized in a specific class was predicted by age, gender, SES and region of residence.

Intake of SSB has considerably increased in Mexico since the beginning of the 21st century, mirroring the increase in the prevalence of obesity (Barquera et al., 2013). This has led the country to introduce taxation policy changes to increase the prices of SSBs, with the aim to discourage people from purchasing and therefore reducing the intake of these products among all population groups in Mexico. However, there is little research about the factors that are the main contributors to SSB intake in all population groups (Theodore et al., 2011) as the focus has only been on the description of average intake of SSBs and its relationship with sociodemographic factors such as age, gender, area of residence (urban vs rural), SES and region. The existent research is limited and tends to assume that SSB intake is normally distributed, the sociodemographic factors are sufficient to make good predictions of intake at any point of the distribution and average differences between sociodemographic groups describe well the SSB intake of the Mexican population. This study attempted to tackle these limitations by drawing on assumptions that permit looking at the relationship between SSB intake and sociodemographic factors on a more flexible manner, (i.e. by not focusing on mean SSB intake differences by sociodemographic variables) but instead examining how SSB intake is associated with different types of consumers. This will facilitate the understanding more about the intake of SSB that can lead to more detailed information that will aid the development of targeted interventions to reduce SSB intake in groups of Mexican population that require further attention, as moderate and heavy consumers.

Classification of SSB consumers has not been previously assessed for the Mexican population. The results from this study showed that there are three types of consumers (classes) and that the relationship between different sociodemographic characteristics and SSB intake varies according to these classes. The proportion of the people within classes varied significantly. The class with the highest SSB intake (1,387 ml/day) was the smallest, representing just 7% of the sample. In contrast, the largest group (75% of the total sample) showed the lowest intake of SSBs (186 ml/day), that is, nearly half the average intake of this sample (350ml/day). In total, 25% of the Mexican population were consuming over half a litre of SSBs per day, with moderate SSB drinkers consuming double the amount of the national average while high SSB drinkers consuming four times the average intake. These results support the heterogeneity of the intake of SSBs in Mexico, which requires further research to ensure that policies and interventions are tailored to different intake groups. For instance, result indicate that moderate and heavy SSB drinker consume very high amounts of SSB a day. Therefore, intervention in these groups might be more useful than intervention for healthy SSB consumer.

The current findings also revealed that the relationship between SSB intake and sociodemographic factors varied across classes of consumers. For instance, the relationship between gender and intake depends on class membership, i.e. it is conditional to the amount of SSB intake. While females were more likely to be classified as healthy SSB drinkers, males did not show to have higher odds to be among the moderate and the heavy SSB drinkers, instead were comprised by a similar share of males and females. This is in contrast with earlier studies examining mean SSB intake differences, which are consistently suggested that males have higher intake of SSBs than females (Aburto et al., 2016; Barquera et al., 2010a, 2008; Caravali-Meza et al., 2016). Concurrently, this findings are in line with previous evidence indicating that females consume healthier amounts of SSBs than males (Barquera et al., 2008; Jimenez-Aguilar et al., 2009; Piernas et al., 2014). Thus, the results of this study pose questions about the extent to which the previous literature has oversimplified the relationship between SSB consumption and gender by focusing on mean differences in SSB intake, instead of providing explicit information on SSB intakes at different points of the distribution.

The literature to date has supported that high intake of SSBs is more prevalent in the northern region of Mexico (Aburto et al., 2016; Barquera et al., 2010b, 2008; Jimenez-Aguilar et al., 2009). The results from the ENSANUT-2006 suggest that the north region had the highest intake of soda and aguas frescas in adults; and soda and sweetened beverages in children (Barquera et al., 2010a, 2008). According to Jimenez-Aguilar (2009), on average, adolescents residing in the north consumed more servings of SSBs per day than inhabitants from other regions. Previous analysis of the ENSANUT-2012 also suggested that the north region has higher caloric intake from SSB (Aburto et al., 2016). Finding from this study show a different pattern across regions, with Mexico City having the highest mean SSB intake, instead of the north. The RMM suggested that the key difference across regions occurred at the top of the distribution, where inhabitants of Mexico City had higher odds, relative to the South, Central and Northern regions, of being in the heavy-drinkers class. This finding suggests that the mean differences across regions cannot be explained by the average consumer but are due to the amount of SSBs consumed by the heavy consumers in Mexico City.

In developed countries, intake of SSBs is consistently associated with low SES (Rehm et al., 2008; Sharkey et al., 2011); however, this relationship is different in middle income countries such as Mexico (see section 2.3.1.1). The results from this study indicate that the healthy SSB drinkers were more likely to be from a low SES whereas moderate SSB drinkers were more likely to be from a middle and high SES. This is in line with previous evidence from ENSANUT-2006 (see section 2.3.1.1) and the ENSANUT-2012 which showed that children from a middle SES had the highest intake of SSB (427 ml/day) relative to low (379 ml/day) and high SES (416 ml/day) (Shamah-Levy et al., 2016). Nonetheless, other study showed no difference in total energy intake from SSBs by SES groups in the whole sample (Aburto et al., 2016). Result from this study, also showed that the only class for which SES was not a good predictor of class memberships was for the heavy SSB drinkers. This may indicate that high intake of SSB is independent from SES.

The results showed that the likelihood of being in the high intake group increases with age, which is supported by previous evidence (Aburto et al., 2016; Batis et al., 2016b; Stern et al., 2014). A key finding from this study shows that adolescents have significantly higher odds to be in the high intake class compared to children and adults. This suggests that special strategies, including policies, should be directed to people between 12 and 19 years with the intention to reduces their SSB intake before the transition to adulthood, when dietary behaviours are established and therefore more difficult to modify (Neumark-Sztainer et al., 2011).

The findings from this study raise many issues for current policies designed to reduce intake of SSBs in Mexico. The recent evaluation of the effect of taxation suggested that the SSB tax has regressive effects (i.e. affects the poorer members of society), as reductions on SSB sales were observed to be higher among low income households (Colchero et al., 2017c). Nevertheless, results from this study suggest that individuals with low incomes were more likely to be among the healthy SSB drinkers, which indicates that the tax might have a stronger effect in the group with the lowest intake and not necessarily in those with severe SSBs intakes, such as moderate consumers (who are more likely to belong to a middle and high SES). Among the heavy consumers, there were not significant differences by SES. These findings raise questions about the limited effect that taxation might have among high consumers, who on average consume over a litre of SSB a day. Etilé and Shama (2015) showed that the relationship between prices and SSB intake weakens at the top of the distribution (i.e. heavy consumers). Data analysed in this study were collected prior to the implementation of the tax, which raises the question about how classes might be affected by taxation and whether classification of consumers has changed over time.

Overall, the results reported in this chapter suggest that sociodemographic factors poorly explain the high intake of SSBs in the Mexican population and this could be due to other individual, social or environmental factors that are determining

SSB intake among heavy consumers. Although the ENSANUT-2012 is a comprehensive survey, it did not assess any environmental or psychosocial variables that might play a role in SSB intake, rendering it difficult to fully understand the predictors of different patterns of SSB intake. According to previous research (presented in Chapter 2) , mostly conducted in developed countries, individual and psychosocial factors such as behavioural intentions, habit strength and taste preferences toward sugar-containing beverages contribute to the intake of SSBs (Tak et al., 2011; Zoellner et al., 2012b, 2012a). The literature also suggests that the food environment also plays an important role in promoting higher intake of SSBs. For instance, the availability and easy access to SSBs in different contexts such as homes, schools and restaurants can predict intake of SSBs among young people (Ezendam et al., 2010; Hebden et al., 2013; Shi, 2010; Wiecha et al., 2006). Finally, social norms and family influences have also been associated with a higher intake of SSBs (Bruening et al., 2012; Lally et al., 2011b). Nonetheless, the relationship between each of these factors and different types of consumers remains unknown. Therefore, further research is needed in Mexico that accounts for the interaction between different factors, and SSB intake in different contexts.

3.4.1 Strengths and Limitations

A strength of the present study is that it puts forward the first classification of consumers of SSBs using finite mixture models in a nationally representative Mexican sample. Moreover, this is the first study in which dietary data from the SFFQ are used to investigate beverage intake in Mexico, as earlier studies have examined dietary data based on 24HR collected as part of the ENSANUT-2012 (Piernas et al., 2014; Sánchez-Pimienta et al., 2016; Stern et al., 2014). A limitation, however, is that neither of the dietary assessment used in the ENSANUT 2012 (SFFQ and 24 HR) has been validated against other objective methods that assess dietary intake more objectively such as biomarkers of food intake, photography and direct observation (this is further discussed in section 9.7.2). Nonetheless, the SFFQ has been subject to criterion validity, that is, validating a specific diet measures against a "gold standard" or an assessment that is considered a better approximation of true intake. Repeated 24HRs (2 or more recalls) have been previously used to validate other self-reported dietary assessment including FFQs (Ma et al., 2009). Recent evidence from studies evaluating the criterion validity between the SFFQ and the repeated 24HR for the ENSANUT 2012 have only been carried out for adolescents and adults but not in children (Denova-Gutiérrez et al., 2016a). Result indicated that the SFFQ estimates for energy and nutrients were higher than those obtained from the mean of the 24HRs, overestimating total energy intake by 265 kcal in adults and 512 kcal in adolescents (Denova-Gutiérrez et al., 2016a). In terms of mean daily consumption of food (g/day) the SFFQ also overestimated intake, more specifically there was an overestimation of soft drinks and other SSBs (Denova-Gutiérrez et al., 2016a). Moderate intraclass correlation (ICC) between the two methods was found for soft drinks and other sweetened beverages (ICC= 0.64; 95% CI= 0.54,0.72; p <0.001 and ICC= 0.47; 95% CI= 0.22,0.6; p <0.001, respectably), a slight overestimation on the intake of soft drinks and another sweetened beverage was reported for the SFFQ (Denova-Gutiérrez et al., 2016b). However, during the present analysis when average intake of each SSB from the SFFQ was compared to the average SSB intake reported in 24 hr dietary recalls (one day) presented in other published literature (Stern et al., 2014), an underestimation of SSB daily intake was observed in the data from the SFFQ. This differences in intake may affect the classification of consumers and underestimate the average intake of SSBs for each of the latent classes. Overall, these studies indicated that SFFQ was suitable tool for the assessment of diet in adolescents and adults in relation to repeated 24HRs. Nonetheless, concerns about validating self-reported diet measure between each other has put forward in the literature, due to correlated error problem where error of one measure is correlated with the error of the other biasing the correlation coefficients of the two measures (Martín-Calvo and Martínez-González, 2018). Therefore, is still important to seek for validation of these dietary assessments against more objective measures such as biomarkers before drawing conclusion of the findings presented in this Chapter and before continuing the use of the SFFQ in future ENSANUT surveys. Despite, it has been acknowledged that there are cost limitation of assessing dietary intake using biomarkers, especially in population-based studies (Freedman et al., 2014),biomarkers can still be useful for improving criterion validity of self-reported methods, such as SFFQ and 24 HR (Rollo et al., 2016).Also, the dietary data collected in the 24HR have information about more types of SSBs that the SFFQ, including energy drinks. Delayed access to data from the 24h recalls did not allow to properly clean and analysed it for the present study, however future research should compare RMM results from the SFFQ and 24hr dietary recalls to see if the same number of classes emerge and whether the classes and sociodemographic factors have similar relationships with the class memberships identified in the current report.

Another limitation of the current study is that the inclusion of the variable area (dichotomous variable, urban and rural) was not possible due to collinearity with the variable region, which affected the model estimation. As mentioned in Section 3.2.3.2, it was of interest to assess whether individuals' BMI differed across classes, separate models by age were run, results indicated no association between BMI and class membership. This could suggest that BMI is a not a predictor of the different levels of SSB consumption in Mexico and that SSB intake is independent of weight status of individual.

3.4.2 Conclusions

The aim of this chapter was to explore the heterogeneity of SSB consumers in Mexico and to assess if available representative data could help to understand to SSB intake among Mexican population. The findings presented in this chapter have provided a different perspective of SSB intake among the Mexican population by using a person-centred approach, namely finite mixture models, thus permitting to identify three homogenous groups of individuals based on their total intake of SSBs. These findings suggest that further empirical research is needed to gain better understanding of SSB intake as data from ENSANUT alone cannot explain the intake of SSBs in Mexico. Moreover, the results have important implication to current policies as they suggest that adolescents are a group of the population with a greater probability to be heavy consumers and that require additional strategies in order to ensure reduction in the intake of SSBs. Although research is needed to identify other potential factors that could be influencing intake of SSB, the current findings suggest that adolescents and those with middle and high SES will benefit more from targeted interventions to reduce SSB intake in Mexico.

3.5 Thesis implications

The findings from this study provide information on the profile of heavy consumer of SSB in Mexico, which includes adolescents, and residents from Mexico City. Moreover, this chapter helped to build up and frame the remaining research question of this thesis. Next chapter will investigate the association of other individual, social, and micro-environmental factors that are associated with the intake of SSB in a sample of Mexican adolescents. This will enable a more insightful understanding of the intake of SSBs in the age group with greater odds to consume higher amounts of SSBs.

Chapter 4 Study 2: Individual, social and environmental factors associated with the intake of SSBs in a sample of Mexican adolescents

4.1 Chapter overview

Chapter 3 (Study 1) demonstrated that adolescents (15-19 years) have higher probabilities to be among the heavy SSB drinker group, compared to adults and children. This underlines the importance of focusing on the adolescent population. As mentioned in Chapter 2, SSB intake has been associated with higher BMI among adolescents in Mexico (Jimenez-Aguilar et al., 2009), and it has been suggested that obesity and overweight during adolescence are likely to remain throughout adulthood, increasing the risk of non-communicable diseases (Craigie et al., 2009; Lake and Townshend, 2006, 2013; Simmonds et al., 2016). Therefore, focusing on reducing SSB intake among adolescents could work as a preventive strategy to reduce risk of obesity and overweight in adulthood.

Study 1, however, was limited as it only considered few factors to examine the intake of SSB in Mexico. The literature review (Chapter 2) showed that in developed countries different individual, social, meso and macro-level factors promote the intake of SSBs in adolescents. Current evidence from Mexico suggests that SSB intake is determined by a lack of access to drinking water (Ortega-Castaneda and Vega, 2016), heavy marketing (Barquera et al., 2018; Pérez-Salgado et al., 2010) and by sociocultural factors such as the importance of SSBs in social events and the norm of combining savoury foods with SSBs (Theodore et al., 2011). Nevertheless, virtually no information is available on whether individual, social and meso-level factors are associated with intake of SSBs in Mexico.

Chapter 2 also reviewed Different theories and frameworks have been proposed to understand SSB intake (see section 2.2), with the majority focusing on individual behaviour. For instance, the Theory of Planned Behaviour (TPB) proposes that individuals will intend to drink SSBs when they evaluate the behaviour as positive (attitudes towards drinking SSBs), when they believe others think they should perform it (subjective norms) and when they perceive it to be under their own control (perceived behavioural control) (Kassem et al., 2003). TPB components have shown positive associations with intake of SSBs in several studies in adolescents (de Bruijn et al., 2007; de Bruijn and van den Putte, 2009; Ezendam et al., 2010; Kassem et al., 2003; Tak et al., 2011; van der Horst et al., 2008). In contrast, the habit theory has proposed that SSB intake is performed with a lack of cognitive behaviour and instead is triggered by environmental cues until it becomes automatic. Moreover, habit strength has been positively associated with adolescents' SSB intake (de Bruijn and van den Putte, 2009; Kremers et al., 2007; Tak et al., 2011; van der Horst et al., 2007) which may indicate the habitual characteristics of SSB intake. Nonetheless, TPB and habit theory have not been utilised in Mexico to examine and understanding the intake of SSB in Mexican population.

On the other hand, other studies have account for other factors representing the broader socioecological model, like perceived SSB intake of parents and peers, and home and school availability and accessibility, have shown consistent positive associations with SSB intake (Ezendam et al., 2010; Hebden et al., 2013; van der Horst et al., 2008). However, no study has simultaneously assessed the association of different factors from all levels of the socioecological model and the intake of SSBs.

4.1.1 Aims and Research Questions

Overall, there are different factors that have been shown to predict the intake of SSBs in specific populations (section 2.3), therefore one of the aims of his study is to investigate if these factors also serve to understand the consumption of SSBs in Mexican adolescents. Chapter 3 showed that standard methods of looking at mean relationships provide a narrow approach to understand SSB intake. For a phenomenon like SSB intake, however, it is important to consider the variability in the intake, as this will help to further explore the relationship between SSB intake and its predictors. Therefore, the second aim of this study is to assess whether the relationship between individual, social, and micro-environment [4] factors and SSB intake differ between adolescents with low and high SSB intake. Finally, as some studies have used behavioural theories, such as TPB and habit theory, to understand SSB intake, the third aim of this study is to test if these theories could help to understand the individual processes that might predict SSB intake in a purposive sample of Mexican adolescents. Therefore, this study will answer research questions 2 and 3 of this thesis:

RQ 2: Is there an association between individual, social, and micro-environmental factors and SSB intake in a sample of Mexican adolescents?

RQ 2.1: Are these associations different at the mean and at different points of the distribution of SSB intake?

RQ 3: Are individual level theories (TPB and habit theory) useful to explain SSB intake in a sample of Mexican adolescents?

The findings from this exploratory study are intended to inform the development of multi-level interventions to reduce intake of SSBs in Mexican adolescents. This is important because Mexico has mainly focused on the policy environment around SSBs, and as such, behavioural and food environmental interventions are virtually non-existent in Mexico. Implementation of multi-level interventions in specific segments of the population that are more at risk of consuming high amounts of SSBs could complement current SSB tax policy.

4.2 Methods

This section describes first the study design and recruitment procedures (section 4.2.1 and 4.2.2), followed by methods for data collection (section 4.2.3), with a detailed description of the tools used, as well as data preparation (section 4.2.4).

[4] Micro-environments are defined by Swinburn et al. (1999) and Hollands et al. (2013) as environments within building like homes, schools, workplaces.

Finally, a description of statistical methods used to address each of the research questions is presented (Section 4.2.5).

4.2.1 Study design

A cross-sectional study was conducted in Hermosillo, the capital city of the state of Sonora, Mexico, in autumn 2015. Sonora was chosen for data collection because it is among the states with the highest prevalence of obesity (36%) nationwide (Gutiérrez et al., 2013) and the fifth state with the highest abdominal obesity prevalence (78%) (Barquera et al., 2013). Sonora is also the home state of the candidate, which facilitated the data collection process.

4.2.2 Participants and recruitment

Eligible participants were adolescents, aged 15-19 years, who had internet access at home and/or school/university (as questionnaires were to be completed online). Participants were identified through private and public high schools and universities in the city of Hermosillo. Institutions were identified using the National System for School Information (Secretaria de Educacion Publica, 2010), which provides an updated directory of all educational institutions in Mexico. During August and September 2015, 60 high schools and 11 universities located in the city of Hermosillo were identified and invited via e-mail (Appendix 6), telephone calls or private appointments with head teachers or heads of faculties to participate in the study. An information sheet was sent alongside the invitation and a consent form was requested to be signed by the school authorities and returned if they agreed to participate (Appendix 6). A total of nine high schools and four universities agreed to take part. The researcher then contacted these institutions with details of how to proceed with the students' invitation. The study procedures were approved by the University of Bristol, School for Policy Studies Ethics Committee (Appendix 1).

4.2.3 Data collection

Data were collected via an online survey using the Online Bristol Survey platform (Appendix 7). Participant read and sign a consent form before starting to fill the survey. The initial aim was for the online survey to be completed by all adolescents during class time in the computer labs. The web format helped to avoid incomplete recordings and inconsistency, and reduced the burden of data handling, which is time consuming and expensive (Medina et al., 2017). However, completion of the online survey in the classroom was not possible in three universities and therefore potential participants in these institutions received a brief information session and the link to the survey was sent to their email. Participants who completed the survey outside the classroom represented 4.3% (n=22) of the total sample. When the survey was completed in the classroom, the researcher was discreetly present to answer any questions or to solve any issues with the survey platform. The same online survey was administered to high school and university participants.

The survey consisted of 90 items that assessed intake of SSBs, determinants of SSB intake, demographic and personal characteristics. The survey was pre-tested for clarity and length by six adolescents not participating in the study. Feedback from adolescent referred mostly to wording of the questions and multiple answers. The survey was amended accordingly. The final survey required approximately 30 to 40 minutes to complete. The following three sections describe each of the survey sections.

4.2.3.1 Assessment of sugar-sweetened beverage intake

As described in section 3.2.1, there are different self-reported dietary assessment methods to measure diet such as food diaries, 24-hour recalls (24HRs) and food frequency questionnaires (FFQs). In the present study, because the main interest was to assess beverage intake only. Because schools provided limited time with students, food diaries and repeated 24HRs were not possible to implement. Dietary assessment was therefore carried out using the Beverage Intake Questionnaire (BEVQ). The BEVQ is a food frequency questionnaire that assesses the habitual intake of 15 beverages by asking participants to report the frequency and amount consumed of each beverage (Appendix 7). The BEVQ has been subject to criterion validity in different population in the U.S. including adults, adolescents and children (Davy et al., 2011; Hedrick et al., 2015; Hill et al., 2017). Davy et al. (2011) used the biomarker $\delta^{13}C$ value [5], which is considered as an objective measure for added sugar and SSB intake, to validate the BEVQ in relation to SSBs intake in adults. Using fingerstick blood it was possible to determine $\delta^{13}C$ value associated with SSB intake. Results indicated that $\delta^{13}C$ value was correlated with total SSBs intake (g and kcal) determined by the BEVQ (kcal: r=0.35, p=0.006 and gr: r =0.28, p=0.02). However, these correlations seem to be under threshold that is considered acceptable in validation studies using biomarker which is r ~0.50 to 0.70 (Davy et al., 2011). Improvements on this biomarker were recently published indicating similar correlation estimates between $\delta^{13}C$ values and SSB intake determined by the BEVQ (r=0.39, p≤0.01) (Hedrick et al., 2015). Despite the relative low correlation between the two methods there is some indication that BEVQ might be a valid instrument to assess SSB intake (Davy et al., 2011; Hedrick et al., 2015). Notwithstanding the limitation of validating self-reported diet measure against each other (see section 3.41), the BEVQ has been validated against 24HR (4 recalls) and food intake records (FIR) in children and adolescents. Results showed that SSB intake from BEVQ was correlated with the average intake of SSB from the four 24HR (children: fl oz/d, r=0.55, p ≤0.001; kcal/d, r=0.50 ≤0.001 and adolescents: fl oz/d, r=0.55, p ≤0.001; kcal/d, r=0.55 ≤0.001). Although, a small overestimation was found for the BEVQ compared with the 24hr in both age groups, the difference was not significant for total SSBs intake (Hill et al., 2017).

To better reflect beverages consumed by the Mexican population, an item was added to assess the intake of *aguas frescas* (sweetened fruit waters), resulting in 16 items in total. Atole (sweetened hot beverage), however was not included in the questionnaire as personal experience and a preliminary analysis of ENSANUT-2012 (unpublished results, not presented in this thesis) showed that atole is not frequently consumed in the north region of Mexico. In addition, the original BEVQ asked participants to report beverage intake in fluid ounces; this had to be modified for the purpose of this study, as in Mexico liquids are

[5] Added sweeteners derived from corn and sugar cane contain high natural concentration of stable carbon isotope called ^{13}C

measured in millilitres (ml). Thus, the adapted BEVQ requested participants to report the frequency of intake (‘never or less than one time a week’/ ‘1 time a week’/ ‘2-3 times per week’/ ‘4-6 times per week’/ ‘1 time per day/ ‘2 times per day’/ ‘3 or more times per day’) and portion size consumed of ‘water’/ ‘100% fruit juice’/ ‘sweetened juice/drinks’/ ‘whole milk’/ ‘reduced-fat milk’/ ‘low-fat milk’/ ‘regular soft drinks’/ ‘diet soft drinks’/ ‘sweetened ice tea’/ ‘tea and coffee with sugar and/or milk’/ ‘tea and coffee with artificial sweeteners and no milk’/ ‘beer and wine coolers’/ ‘hard liquor’/ ‘wine’/ ‘energy and sport drinks’ and ‘aguas frescas’. Portion size was reported in ml and cup equivalents (‘less than 180 ml (3/4 cup)’/ ‘240 ml (1 cup)’/ ‘360 ml (1 ½ cups)’/ ‘480 ml (2 cups)’/ ‘600 ml (2 ½ cups) or more’). Pictures of portion sizes were provided to facilitate responses (Appendix 7).

To calculate daily intake (ml) of SSBs (sweetened juice/regular soda/ sweetened ice tea/ tea and coffee with sugar and/or milk/energy and sport drinks and aguas frescas), first the amount in ml was multiplied by the conversion factors for the frequency of intake which were provided by the authors who developed the questionnaire. Then the total average daily intake of SSBs (ml) was then calculated by summing the daily intake of each SSB.

4.2.3.2 Determinants of SSB intake

This section of the survey comprised 44 questions that were used to assess individual, social and meso-level constructs, commonly reported to have a relationship with SSB intake. Due to the lack of research in Mexico, the questions were adapted from earlier questionnaires assessing correlates of SSB intake in European adolescents (Bere et al., 2008; Ezendam et al., 2010; Tak et al., 2011; van der Horst et al., 2008, 2007) and reflected on behavioural theories used to understand SSB intake (TPB and habit theory).

Twenty four questions assessed five individual constructs related to SSB intake, including perceived tastiness of SSBs, measured on a 10-point scale (ranging from 0, ‘not tasty at all’ to 10, ‘very tasty’) (Bere et al., 2008) and psychosocial factors from the TPB and habit theory. As described in Chapter 2 (section 2.2.1), the key constructs of TPB are attitudes, subjective norms and perceived behavioural control (PBC), therefore the development of the TBP questionnaire was based on the guidelines for by Francis (2004), and from previous studies that used the TPB to explain SSB intake in adolescents (Table 2.2).

Attitudes toward limiting SSBs measured whether adolescent considered reducing their intake of SSBs as 'good or bad' and 'pleasant or unpleasant' (De Bruijn et al., 2007; Zoellner et al., 2012a). Two items assessed parental and peer subjective norms (perception of parental and peer pressure to drink SSBs)(De Bruijn et al., 2007; Ezendam et al., 2010; van der Horst et al., 2007). Perceived behavioural control (PBC) was assessed in the context of limiting SSBs (how easy or difficult it is to consume fewer SSBs, and the likelihood of succeeding or failing) using two items. Intention to reduce SSBs in the upcoming year was assessed with one item (De Bruijn et al., 2007; Ezendam et al., 2010).

The Self-Reported Habit Index (SRHI) by Verplanken and Orbell (2003) was used to assess habit strength. The index consists of 12 items that aims to assess five features of habit: 1) the history of repetition of behaviour; 2) lack of control; 3) lack of awareness; 4) efficiency ; and 5) self-identity with the behaviour (Verplanken and Orbell, 2003). The SRHI has been validated in Spain, therefore the Spanish version of the SRHI was used in this study (Gutiérrez-Sánchez and Pino-Juste, 2011). Also, the SRHI has been used to detect habit-behaviour association and to examine the intention-behaviour relationship for other dietary behaviour, which is in line with the objectives of this study (Gardner et al., 2012a, 2011).

Five questions were used to assess two social constructs related to SSB intake, including perceived parental and peer modelling, reflecting whether adolescents' parents and peers drink SSBs and the frequency of intake (Bere et al., 2008; van der Horst et al., 2007). The assessment of micro-environmental constructs involved 19 questions relating to home and school availability ('vending machines'/ 'canteen counter') of SSBs. Accessibility of SSBs at home was assessed by measuring the frequency of SSB intake during meals and outside meal times (Bere et al., 2008; Ezendam et al., 2010; van der Horst et al., 2008). All constructs were assessed using a Likert-type scale (e.g. ‘not at all’ - ‘very much’) and semantic differential scales with bipolar adjective pairs (e.g. ‘good’ – ‘bad’) (see Table 4.1).

4.2.3.3 Demographic and personal characteristics

Demographic questions included gender, age, school year (‘1st year of high school’/ ‘2nd year of high school’/ ‘3rd year of high school’/ ‘1st year of university’), name of school and living situation (‘living with parents’/ ‘living with other family member’/ ‘living alone’/ living with friends’/ ‘other’). Participants were asked to self-report their weight (in kg) and height (in meters), which was used to calculate Body Mass Index (BMI= kg/m^2).

There is a lack of consensus on how to measure the socio-economic status (SES) in developing countries, such as Mexico. Some measures combine educational attainment and employment/occupation (Buchmann and Hannum, 2001; Galobardes et al., 2006). More recently, asset indices have been suggested to better measure socio-economic status in low- and middle-income countries, which can be further extended by adding dimensions such as education and employment status of the head of the household, as they give a better reflection of how stratified a society is (Howe et al., 2012). Based on Howe et al. (2012) in the present study, SES was assessed based on the following indices; (i) an asset index comprising availability of basic and non-basic goods and durables (‘car’/ ‘microwave’/ ‘stove’/ ‘fridge’/ ‘washing machine’/ ‘computer’/ ‘TV’/ ‘DVD player’/ ‘cable TV’/ ‘internet’/ ‘number of bedrooms’ and ‘number of bathrooms with shower’ and ‘flooring materials’); and (ii) educational attainment of the household head (‘no studies’/ ‘primary school’/ ‘incomplete primary school’/ ‘secondary school’/ ‘incomplete secondary school’/ ‘technical career’/ ‘bachelor degree’/ ‘incomplete bachelor degree’/ ‘master’s degree’ and ‘doctorate degree’).

4.2.4 Data preparation and variable reduction

Scores for each construct were calculated by summing the values of each of the items table 4.1 shows the number of items per construct and the scale used to measure each of the items. Before summing the items for each construct, internal consistency of the different scales was evaluated using Cronbach's alpha. Most of the scales had good internal consistency (α>0.60) (see Table 4.1) However, those constructs consisting of only two items had a lower Cronbach's alpha, as Cronbach's alphas tend to underestimate reliability of two-item scales. But even in these cases, Cronbach's alpha was >0.50.

The score for school availability was intended to be constructed using two items: availability of SSBs from vending machines and from the school canteen, however, due to low Cronbach's alpha (α=0.40) it was decided to not sum the items and to include them in the models separately. The SES index was constructed by calculating each domain (assets and education) separately (Howe et al., 2012). The asset domain score was calculated using the sum of items (each item had the same weight). Three variables were dichotomized: the number of bedrooms (overcrowding > 2.5), the number of baths with shower (lacking bathrooms with shower) and flooring materials (tiled floor). The total was divided by the maximum score. The same procedure was utilized for the education variable. The SES index was then calculated by standardizing assets and education scores and combining the resulting indices (Howe et al., 2012).
All variables were re-scaled (from 1 to 10) to facilitate interpretation and to be directly associated with the concept they measured, i.e. a higher value (10) indicated higher availability.

Table 4.1 Characteristics of the constructs included in the study

Construct	no. Items	Scale	Cronbach α
Individual			
Taste of SSBs	6	0 to 10 scales: not tasty -very tasty	0.81
Attitudes toward limiting SSBs	2	5-bipolar scale: bad-good, unpleasant-pleasant	0.79
Subjective norms to limit SSBs	2	5-likert scale: totally disagree- totally agree	0.56
Perceived behavioural control	2	5-likert scale: very difficult-very easy, fail-succeed	0.58
Habit	12	5-likert scale: Totally disagree- totally agree	0.90
Intention to limit SSBs	1	5-likert scale: Definitely no- definitely yes	N/A
Social			
Peer modelling	3	5-likert scale: Definitely no- definitely yes Never- many times a day	0.59
Parental modelling	2	5-likert scale: Definitely no- definitely yes. Never- many times a day	0.76
Micro-environment			
Home availability	1	5-likert scale: Never-always	N/A
Home accessibility	2	1 to 10 scale: Never- always	0.79
School vending machine availability	8	yes-no	0.84
School canteen availability	8	yes-no	0.78
SES			
Household Assets	12	Yes-no: Car, microwave, computer, TV, DVD, paid TV, internet, overcrowding (no. rooms+ no. people in the house), no. bathrooms, type of floors	0.83
Parental education	1	No education- postgraduate	N/A
SES index	2	z-score asset + z-score education	0.57

4.2.5 Statistical analyses

Descriptive statistics (means, frequencies and standard deviations) were utilized to explore SSB intake, determinants of SSB intake, demographic and personal characteristics. Independent samples t-tests (for continuous variables) and Chi-square tests (for categorical variables) were used to investigate any differences in these variables between males and females. Spearman and Kendall's correlation were used to explore associations between constructs and SSB intake. The use of Spearman and Kendall's correlation are appropriate when one of the variables is ordinal (ordered such that one level can be considered higher/lower than another), as is the case for most of the variables measuring different factors. Three main statistical approaches were used to answer the three main research questions of this chapter: regression on the mean, regression mixture model and cross-sectional mediation analysis.

4.2.5.1 Mean association among SSB intake and individual, social and micro-environmental factors

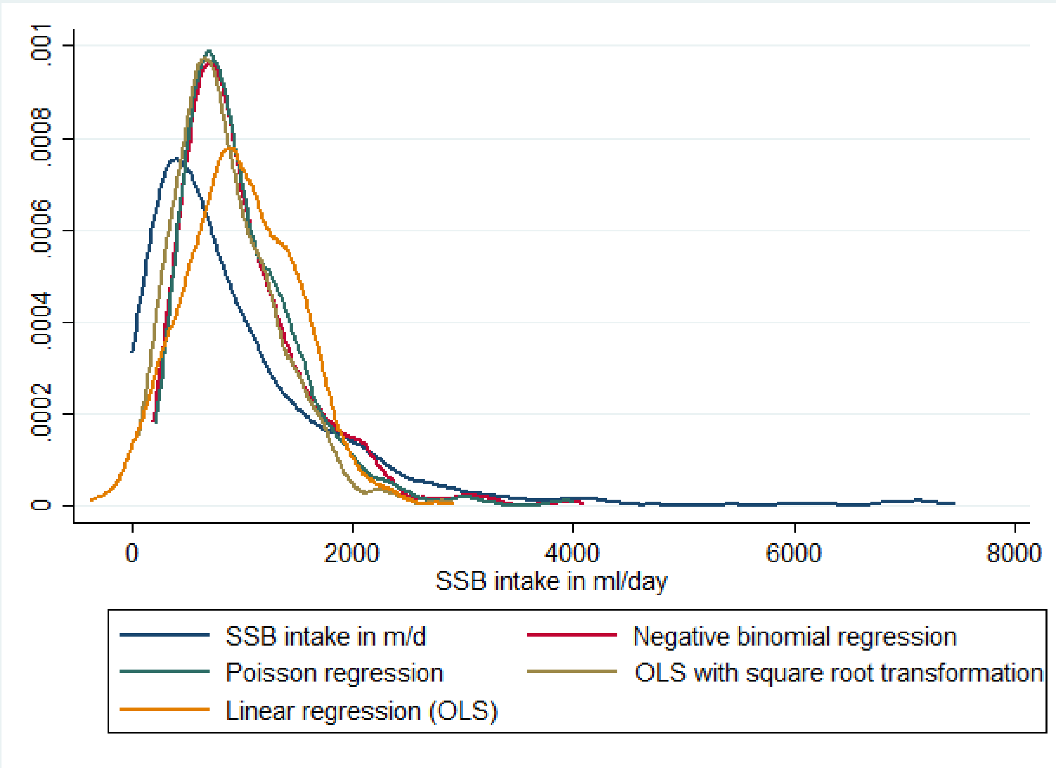
This section describes the methods used to answer RQ 2. Considering previous empirical studies about the relationship between SSB intake and different types of factors, a linear regression model was considered to analyse the mean relationship between total intake of SSBs (dependent variable) and different factors (independent variables). However, since SSB intake was not normally distributed and this is a relatively small sample, the regression residuals were checked to ensure that linear regression assumptions were met (Chen et al., 2017; Wooldridge, 2010). First, the normality of the residual was analysed using the Kernel density estimate, standard normal probability plot and the Shapiro-Wilk test (Appendix 8), which showed that residuals were not normally distributed. The second assumption was homoscedasticity or homogeneity of the variance of the residuals. This was analysed using a graphical method, which suggested that the variance of the residuals was non-constant and therefore heteroscedastic (Appendix 8). Third, multicollinearity was also checked using the variance inflation factor. Values ranged from 1 to 1.3 (values greater than 10 or lower than 0.1 indicate multicollinearity), suggesting no linear relationship among any of the predictors (Chen et al., 2017). Fourth is the assumption of linearity between SSB intake and the predictors, thus standardized residuals were plotted against each of the factors included in the regression. As shown in Appendix 8, none of the associations showed linearity. All these assumptions mentioned above are of less importance, particularly normality of the residuals, with large sample sizes due to central limit theorem, however with small samples it is important to not violate these assumptions as will result in biased estimates (Field, 2009).

The issue of non-normality of SSB intake has been reported in previous literature, where transformation of the variable using logarithmic transformation (Hearst et al., 2009; Tak et al., 2011; Vågstrand et al., 2009; Van Lippevelde et al., 2013) and square root transformation (de Bruijn et al., 2007) has been useful to improve normality. To assess which transformation might be suitable for the current data, the *gladder* command in Stata was applied to the response variable. This suggested that square root transformation was appropriate for these data (see Appendix 9). Then, a linear regression with transformed SSB intake was fitted. The analysis of the regression residuals (Appendix 10) showed that, despite improvement due to transformation, linear regression assumptions were not met. Furthermore, the transformation of the response variable leads to other sort of problems like finding an appropriate back-transformation, a more complex interpretation of the coefficients and, more importantly, in forcing the data to have a different distributional form that leads to an information loss of the underlying non-linear relationship between the dependant and the independent variables (Gelman et al., 2014).

One critical aspect of linear regression is that it assumes that the relationship between variables is proportional (i.e. a change in the independent variable will lead a constant increment of the dependant variable). Contemporary statistical literature proposes more powerful, adequate and flexible models that do not constraint relationships between variables to be governed by normality and linearity. For example, non-linear regression models, such as Poisson regression and negative binomial regression (NBR), are appropriate when the independent variable is does not have negative values (zero-bounded), truncated and the most common values are not at the centre of the distribution (skewedness). Both are a special case of the Gamma distribution (Long and Freese, 2001; Wooldridge, 2010). The main difference between Poisson and negative binomial regressions is that the latter accounts for overdispersion (variance higher than the mean), which is the case with this data.

The existence and implementation of different modelling alternatives has several advantages. First, it permits a cross-validation of the coefficients of the different models and an assessment of the stability of the results under different modelling assumptions. Second, it is also useful in terms of preserving a connection with previous empirical literature that is based on linear models but, at the same time, it helps to move forward the empirical agenda on the analysis of SSB intake. Therefore, a sensitivity analysis among the four models (linear regression with transformed variables, NBR and Poisson regression) was performed to check the direction and effect sizes across models (Appendix 12) and the fit of each regression model to the data (Figure 4.1). The results suggested that, most of the regression coefficients did not differ in the direction (positive and negative) and significance across models, with the exception of taste, parental and peer modelling, and home accessibility. As comparison among effect sizes was not possible due to differences in coefficient metrics. As shown in Figure 4.1, linear regression (yellow line) differed the most from the data, while linear regression with transformed variable, Poisson regression and NBR models fitted the data better. Nonetheless, the Poisson and NBR (red and green lines, respectively) accounted better for the overdispersion of the data. Therefore, the negative binomial regression is presented in the result section. Regression coefficients are presented in incidence rate ratios, which are easier to interpret, compared to linear regression with squared root transformation coefficients that can be found in the Appendix 11.

Figure 4.1 Graphical sensitivity analysis among different regression analyses

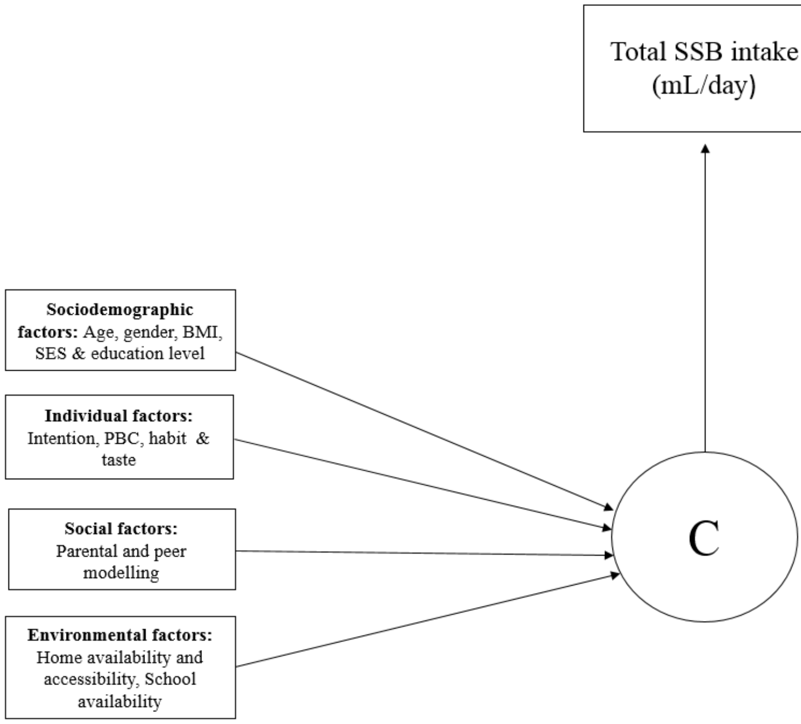


All models were adjusted for age, gender, BMI, SES and robust standard errors were used to account for the clustering of participants in schools and universities (Kirkwood and Sterne, 2003). To account for any potential differences in social and environmental factors playing a role in SSB intake between high school and university students, models were also adjusted for educational level and three interaction terms were added to the regression models, to assess if school availability, peer modelling and peer subjective norms operated differently in these two settings. Interaction terms did not include items related to the home environment, as only 7 university participants lived outside the family home, and therefore it was highly unlikely that the home environment differed between high school and university participants. The models presented refer to all participants, as there was no evidence that excluding the 22 participants who completed the survey outside the classroom had a noticeable impact on findings.

4.2.5.2 Association among factors and different classes of SSB intake

This section describes the methods to answer RQ 2.1. The previous section described the modelling analysis to assess the mean relationship between different factors and SSBs. Nonetheless, regression assumes that the reported effects are sufficient to understand the statistical effect of a variable upon very high and very low intake values, which may not be the case. In order to assess the association among factors and different SSB intake levels, a regression mixture model (RRM) was used. As previously described in Study 1 (Chapter 3), RMM is a method that enables the classification of SSB consumers based on their total intake of SSBs. It is then possible to examine how individual, social and environmental factors associate with the different types of consumers. Therefore, the first step was to determine the optimal number of classes based on the model fit statistic, namely Bayesian information criteria (BIC) and the sample-size adjusted criterion (SABIC). The quality of classification was assessed by entropy, which ranged from 0-1, where values closer to 1 indicate good classification of individuals. Individual, social and environmental factors were then incorporated into the model as predictors of the latent class (Figure 4.2). Predictors were included using both the 1-step and 3-step approach (described in Chapter 4, section 4.2.4), with different parameter constraints to allow different variances. However, the 1-step approach performed better than the 3-step, as is suggested in the literature (Kim et al., 2016). All models accounted for clustering of schools.

Figure 4.2 Path diagram of the regression mixture model with individual, social and environmental variables predicting class membership (the probability of an individual to be assigned to a specific latent class)



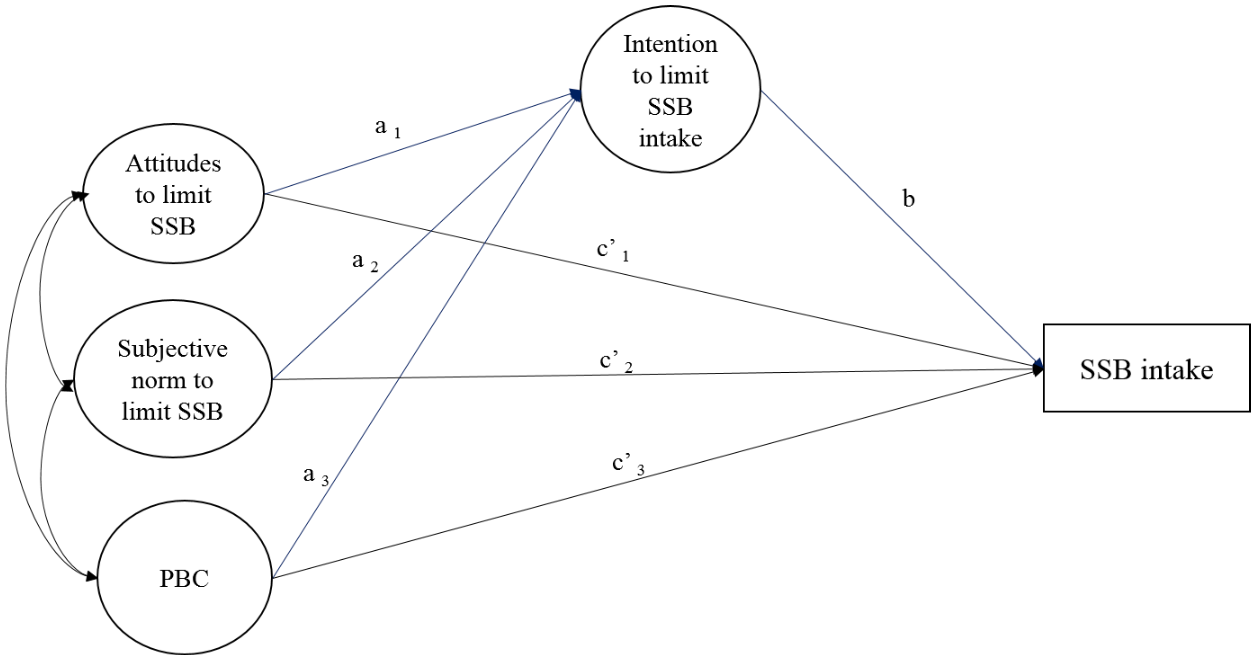
4.2.5.3 Mediation and moderation analysis of TPB and habit theory

This section describes the methods to answer RQ 3, which involved testing if individual level theories explained intake of SSBs in Mexican adolescents. Initially correlations were estimated to test if the TPB and habit theory applied to these data. Spearman's and Kendall's correlations were used to assess the relationships among constructs that are known to have a theoretical relationship between each other. The correlations table is presented in Table 4.5 in the result section. The next step was to conduct a mediation analysis to test the TPB, by assessing whether attitudes to limit SSB intake, subjective norms to limit SSB intake, and PBC predicted SSB intake via intentions to limit SSBs (mediator) (Figure 4.3). Path analysis, a subset of structural equation modelling (Fairchild and Mcdaniel, 2017; Kirkegaard et al., 2013) was used to assess the direct effect [6]

[6] The word effect is used a standard terminology for the results from the path analysis and it refers to statistical effect and not to causal effect (Kirkegaard et al. 2013)

of a set of variables on the outcome (paths *c'*) and the indirect effects via the mediator (paths *a* and *b*), by simultaneously estimating a set of regressions (Muthén et al., 2016). The path analysis was adjusted for the following covariates: gender, age, BMI and SES.

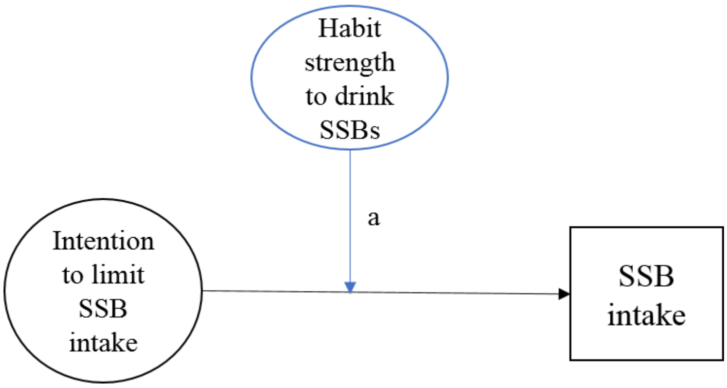
Figure 4.3 Path diagram presenting the theoretical association between TPB constructs



The maximum likelihood estimator was used with bootstrap, a re-sampling method that adjusts for the small sample and the non-normal product of coefficients (Mackinnon, 2008). The model controlled for clustering to account for adolescents nested within school. The chi-square test (larger p-values >0.05 are desired), Comparative Fit Index (CFI) and Tucker Lewis index (TLI) (a good fit is when CFI≥90 and TLI ≥95), and also the Root Mean Square Error of Approximation (RMSEA) (where values closer to zero represent a good fit <0.08) were used to assess the model fit (Hooper et al., 2008; Muthén et al., 2016).

Further, in order to test the hypothesis that habit strength to drink SSBs moderates the relationship between intention to reduce intake and intake of SSBs (see path *a* in Figure 4.4) (Gardner, 2015), moderation analysis (also known as effect modification) was conducted. Moderated analysis implies that a moderator, in this case habit, would change the effect (size or sign) of the association between intentions and SSB intake (Hayes, 2017; Muthén et al., 2016). Based on the hypothesis by Triandis (1977), habit strength is expected to diminish the association between intentions and SSB intake. The lack of correlation between intention and habit flagged out potential problems with the model. When running the moderation analysis, the model did not converge, therefore the moderation hypothesis could not be tested with these data.

Figure 4.4 Path diagram presenting habit theory suggested moderation



Data preparation, descriptive statistics and regression models were carried out using Stata 14 (Statacorp, College 82 Station, TX). Mixture regression models, mediation and moderation analyses were performed using Mplus version 8 (Muthén and Muthén, 2017).

4.3 Results

This section first presents the personal characteristic of participants followed by their daily beverage intake. This is followed by the result of the regression on the mean between SSB intake and different predictors (Section 4.3.1). Then results of regression mixture model are presented in Section 4.3.2. Finally, in section 4.3.3 present the findings of the mediation analysis. Participants' characteristics are presented in Table 4.2. In total, 517 participants completed the online survey, but nine responses were excluded because participants were older than 19 years and therefore not considered eligible (World Health Organisation, 2014b) and one observation was considered an outlier as it showed a consumption of more than 10 litres of SSBs per day. The final sample consisted of 507 adolescents (mean age 16.9 years; 53.7% males). Most participants (90.2%, n=458) were high school students. Almost all participants (98% high school and 91% of university) reported living with their parents or family members. The mean SES score for the total sample was 6.5 (SD 2.3), indicating that participants' parents were educated and had a high standard of living.

Table 4.2 Demographic and personal characteristics of study participants

Personal Characteristics	Total (n= 508) Mean (SD)/ n (%)	Females (n=235) Mean (SD)/ n (%)	Males (n=273) Mean (SD)/ n (%)	P [a]
Age (years)	16.9 (0.9)	16.8 (0.9)	16.9 (1.0)	0.11
Weight (kg)	64.2 (14.5)	58.4 (10.7)	70.8 (15.4)	<0.001
Height (m)	1.68 (0.09)	1.62 (0.06)	1.75 (0.07)	<0.001
BMI (kg/m^2)	22.4 (4.0)	22.0 (3.7)	22.9 (4.4)	0.01
Living situation				0.61
Living with parents/ family	497 (97.8)	267 (52.5)	230 (45.2)	
Living alone	3 (0.5)	1 (0.8)	2 (0.3)	
Living with friends	3 (0.5)	2 (0.7)	1 (0.4)	
Other	5 (0.9)	3 (1.1)	2 (0.8)	
Educational level				0.13
1st year of high school	41 (8)	20 (7.3)	21 (8.9)	
2nd year of high school	166 (32.6)	91 (33.3)	75 (31.9)	
3rd year of high school	251 (49.4)	143 (52.3)	108 (45.9)	
1st year of university	50 (9.8)	19 (6.9)	31 (13.1)	
Socio-economic factors				
Parental educational level				0.04
Primary education or less	137 (26.9)	85 (31.1)	52 (22.1)	
Secondary education	229 (45)	121 (44.3)	108 (45.9)	
Tertiary education	142 (27.9)	67 (24.5)	75 (31.9)	
SES (0-10) [b]	6.5 (2.3)	6.4 (2.4)	6.7 (2.1)	0.12
Participants' type of education				
High schools				0.45
Public	168 (33.1)	89 (32.6)	79 (33.6)	
Private	290 (57.9)	165 (60.4)	125 (53.2)	
Universities				0.001
Public	44 (8.6)	14 (5.1)	30 (12.7)	
Private	5 (0.9)	5 (1.8)	0 (0)	

BMI, body mass index; SD, standard deviation; SES, socio-economic status [a] Differences between genders were examined using the Chi-square test and Independent samples t-test. [b] SES scores ranged from 0 to 10, with 0 indicating the lowest and 10 indicating the highest SES.

Most participants (98.4%) reported drinking SSBs during the week and 78.7% on a daily basis. The total average daily intake of SSBs was 944.9 ml/day (SD 1099.8), and regular soda were the most consumed SSBs with an average daily intake of 234.5 ml/day (SD 405.5), followed by sweetened iced teas (167.4 ml/day; SD 298.9) and *aguas frescas* (163.9 ml/day; SD 293.2). Males had a higher SSB intake, compared to females (1,278.8 vs. 769.5 ml/day; t (515), P<0.001) (Table 4.3).

Table 4.3 Mean daily beverage intake of study participants

Beverage ml/day	Total (n=508) Mean (SD)	Females (n= 235) Mean (SD)	Males (n=273) Mean (SD)	P [a]
Water	1109.0 (563.8)	1089.4 (588.8)	1133.0 (533.2)	0.37
100% fruit juice	153.4 (236.3)	121.9 (200.0)	190.1 (268.4)	0.001
Sweetened juices/drinks	150.9 (280.1)	128.8 (243.9)	176.6 (315.7)	0.05
Whole milk	224.2 (351.1)	153.6 (317.9)	284.3 (385.5)	<0.001
Reduced-fat milk (2%)	125.9 (303.1)	98.8 (270.5)	145.1 (339.2)	0.08
Low-fat milk (1%)	73.1 (263.6)	72.4 (41.7)	65.6 (272.2)	0.10
Regular soft drinks	234.5 (405.5)	153.6 (348.8)	297.1 (464.8)	0.72
Diet soft drinks	23.3 (137.2)	18.8 (134.3)	23.9 (140.5)	0.67
Aguas frescas	163.9 (293.2)	143.8 (239.3)	187.0 (344.5)	0.45
Sweetened iced teas	167.4 (298.9)	127.7 (223.4)	213.5 (362.7)	0.001
Coffee and/or tea, with sugar	92.4 (186.4)	81.3 (155.0)	105.3 (217.8)	0.001
Tea or coffee, no sugar	53.0 (200.0)	45.5 (166.4)	54.6 (234.0)	0.14
Beer, Ales, Coolers, Light Beer	40.5 (150.8)	21.6 (61.6)	49.0 (211.2)	0.04
Hard liquor	30.9 (159.5)	18.3 (112.5)	39.0 (200.3)	0.002
Wine	19.3 (162.4)	5.6 (42.7)	34.5 (233.6)	0.04
Sports and energy drinks	135.5 (276.2)	73.5 (156.1)	207.6 (356.8)	<0.001
Total beverage intake	2798.8 (1979.4)	2355.3 (1404.5)	3207.7 (2421.5)	<0.001
Total SSB intake [b]	944.9 (1099.8)	769.5 (52.0)	1278.8 (1404.5)	<0.001

SSB, sugar-sweetened beverages, [a] Differences between genders were examined using the Independent samples t-test. [b] To calculate the total average daily intake of SSBs, the amounts in ml of six SSBs (sweetened juice/ drinks, regular soft drinks, sweetened ice teas, coffee or tea with sugar, sports and energy drinks, and sweetened fruit waters) were summed.

The mean individual, social and environmental factor scores related to SSB intake are presented in Table 4.4.

Table 4.4 Individual, social and environmental factors related to sugar-sweetened beverage intake and cognitions to reduce intake of study participants

Construct [scale 1-10]	Total Mean (SD)/ n (%)	Female (n=235) Mean (SD)/ n (%)	Males (n=273) Mean (SD)/ n (%)	P [a]
Taste preferences	6.6 (2.3)	6.3 (2.4)	6.9 (2.2)	0.001
Attitudes to limit SSBs	5.7 (2.7)	5.7 (2.7)	5.8 (2.7)	0.89
Subjective norm to limit	5.3 (2.6)	5.4 (2.6)	5.1(2.4)	0.13
Perceived behavioural control	6.4 (2.4)	6.4 (2.5)	6.5 (2.3)	0.43
Intention to reduce SSBs	6 (2.7)	6.3 (2.7)	5.5 (2.7)	0.001
Habit strength	4 (2.2)	3.8 (3.5)	4.1 (3.8)	0.16
Parental modelling	5.7 (2.1)	6 (2.1)	5.5 (2.0)	0.04
Peer modelling	6.8 (1.8)	6.7 (1.9)	7 (6.7)	0.21
Home availability	5.6 (2.5)	5.6 (2.6)	5.6 (2.4)	0.92
Home accessibility	3.8 (2.6)	2.8 (2.6)	3.5 (2.8)	0.004
School availability (vending machines)	2.5 (3.4)	2 (3.2)	3 (3.5)	0.002
School availability (canteen)	6.6 (3.4)	6.6(3.5)	6.7 (3.3)	0.72

[a] Differences between genders were examined using the Chi-square test and Independent samples *t*-test. All constructs were scale 1 to 10

Both Spearman and Kendall correlation indicated that almost all variables were correlated with SSB intake (i.e. different from zero) (see Table 4.5). There was no evidence of a correlation among SSB and BMI, age and SES attitudes, subjective norms and parental modelling. Nonetheless, correlation coefficients were generally weak (r<0.4) (Tak et al., 2011).

Table 4.5 Correlation between average daily SSB intake and individual social and environmental factors and correlation between Intentions and TPB correlates and habit

	Spearman's		Kendall's	
	r	**p value**	**r**	**p value**
SSB intake				
BMI	-0.03	0.53	-0.02	0.52
Age	0.07	0.13	0.05	0.13
Gender	-0.25	<0.001	-0.21	<0.001
SES	-0.07	0.08	-0.05	0.09
Attitudes toward limiting SSB	-0.03	0.38	-0.03	0.38
Subjective norm to limit	0.08	0.05	-0.06	0.05
PBC	-0.16	<0.001	-0.12	<0.001
Intention	-0.14	<0.001	-0.11	<0.001
Habit	0.39	<0.001	-0.27	<0.001
Taste	0.27	<0.001	0.19	<0.001
Peer modelling	0.16	<0.001	0.12	<0.001
Parental modelling	0.07	0.09	0.05	0.08
Home availability	0.27	<0.001	0.2	<0.001
Home accessibility	0.35	<0.001	0.25	<0.001
School availability -vending machines	0.14	<0.001	0.10	<0.001
School availability- canteen	0.15	<0.001	0.11	<0.001
Intentions				
Attitudes toward limiting SSB	0.12	0.005	0.10	0.005
Subjective norm to limit	0.26	<0.001	0.21	<0.001
PBC	0.15	<0.001	0.12	<0.001
Habit	-0.07	0.07	-0.06	0.06

4.3.1 Regression on the mean (RQ 2)

The final regression model (negative binomial) using the mean intake of SSBs is presented in Table 4.6. The coefficients are incident rates ratios, which express in relative terms how high or low the consumption of SSBs is depending on changes in the predictor variables. The incidence rate for SSB intake for females was 30% lower than the incidence rate for males, holding the other variables constant. The percentage change in the incident rate of SSB decreased 9% for every unit increase in SES.

Table 4.6 Negative binomial regression

SSB (ml/day)	IRR[a]	Robust SE	[95% CI]	P value
Gender (ref males)	0.69	0.06	[0.59,0.82]	<0.001
Age	1.02	0.05	[0.93,1.11]	0.72
BMI	1.00	0.01	[0.98,1.02]	0.87
SES	0.91	0.02	[0.87,0.96]	<0.001
Education level	0.96	0.41	[0.41,2.20]	0.92
Individual factors				
Intention	0.98	0.02	[0.94,1.02]	0.39
PBC	1.00	0.01	[0.97,1.02]	0.75
Habit	1.12	0.02	[1.07,1.16]	<0.001
Taste	1.04	0.02	[1.00,1.07]	0.03
Social factors				
Parental modelling	0.95	0.02	[0.90,1.00]	0.03
Peer modelling	1.02	0.03	[0.96,1.08]	0.56
Micro-environmental factors				
Home availability	1.07	0.01	[1.05,1.09]	<0.001
Home accessibility	1.03	0.02	[0.99,1.08]	0.09
School availability vending machines	1.04	0.01	[1.01,1.06]	<0.001
School availability canteen	1.01	0.02	[0.97,1.05]	0.63
Interactions (ref: high school)				
Education level vs. peer modelling	1.06	0.04	[0.98,1.15]	0.12
Education level vs. school availability vending machines	0.88	0.03	[0.82,0.95]	0.001
Education level vs. school availability canteen	0.96	0.03	[0.90,1.02]	0.17

SSB, sugar-sweetened beverages; BMI, body mass index; SES, socio-economic status; PBC, perceived behavioural control; IRR, incidence rate ratios; SE, standard error; CI, confidence interval. All variables were included simultaneously in the model

For every unit increase in habit score, the incidence rate for SSB intake increased by 12% while holding all other variables constant. For those adolescents who increased their taste preference score by one unit, the incidence rate for SSB intake increased by 4% while holding all the variables constant. For one unit increase in parental modelling, the rate for SSB intake decreased by a factor of 5%. The percentage change in the incident rate of SSB intake was a 7% increase for every unit increase in home availability. Moreover, for every unit increase in school availability through vending machines, the incidence rate for SSB intake increased by 4%, however the incidence rate decreased for those adolescents in university compared to those in high school (IRR=0.88; 95% CI: 0.82,0.95; p=0.001). There was no evidence that intention, PBC, peer modelling, home accessibility and school availability from the canteen were associated with the intake of SSBs.

4.3.2 Regression mixture model (RQ 2.1)

4.3.2.1 Class selection

Different models with an increasing number of classes, with free and equal parameters (variance) and using both the 1-step and 3-step approaches were fitted. A total of 15 models were estimated, those models with the 1-step approach showed a better model fit than the 3-step model (Table 4.7), as is suggested in previous literature (Kim et al., 2016). From the models resulted from the 1-step approach, those with the free variance performed better that the model with equal variance (Table 4.7). In terms of number of classes, the 3-class model showed the lowest BIC, while the 4-class model showed the lowest SABIC and higher entropy. However, when checking the estimate from the 4-class model some convergence problems were found, which affected the estimation of several coefficients. Then the 5-class model was checked but it clearly showed that it was dividing one class in two. Therefore, the 3-class solution with free variance was chosen.

Table 4.7 Model fit for the regression mixture model

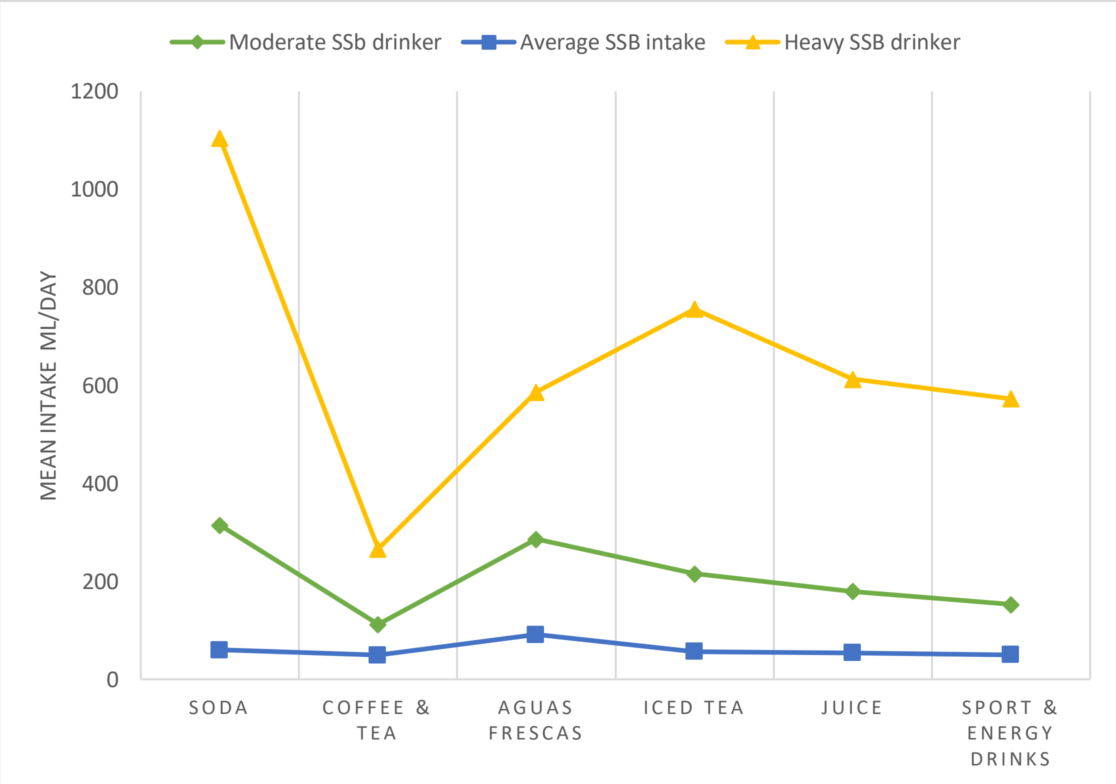
	1-step							
	Free variance				Equal variance			
	2-Class	3-class	4-class	5-class	2-Class	3-class	4-class	5-class
BIC	1196	**1002**	1022	1088	1196	1130	1161	1194
SABIC	1136	**882**	844	853	1136	1016	993	972
Entropy	0.99	**0.72**	0.88	0.73	0.99	0.93	0.84	0.97
	3-step							
BIC	1159	1080	1067	1073	1268	1174	1117	1110
SABIC	1143	1055	1032	1029	1256	1155	1092	1078
Entropy	0.61	0.66	0.62	0.67	0.98	0.93	0.92	0.9

BIC= Bayesian information criteria; SABIC= Sample-size adjusted criterion

Class 1 was labelled “moderate SSB drinkers” as they showed an average intake of SSBs of 1,193 ml/day, representing 43% of the sample. Class 2 was labelled “average SSB drinkers”, as adolescents classified in this group showed the lowest intake of 374 m/day which is closer to the national average SSB intake of 426 ml/day. However, they were the largest class, representing 50% of the sample. Class 3 labelled “heavy SSB drinkers”, showed the highest intake of SSBs with an average intake of 3,339ml/day, however this class was the smallest with 7% in the sample classified here.

Figure 4.5 presents the pattern of SSB intake per class. The “moderate SSB drinkers” and the “low SSB drinkers” showed a similar pattern of beverages. Nonetheless, coffee and tea were the least consumed beverages in the “moderate SSB drinkers” class. The “high SSB drinkers’, however, showed a very high intake of soda, followed by iced teas and relatively low amount of coffee and tea, while the intake of *aguas frescas*, juice and sport and energy drinks were similar between each other.

Figure 4.5 Mean daily intake of each SSB by class



Results from the logistic regression are presented in Table 4.8 where the reference class is the “average SSB drinkers”. Model results with reference groups were high and moderate SSB drinker classes can be found in Appendix 11. Female adolescents, compared to males, showed eight times greater odds to be in the “average SSB consumers” class than in the “heavy SSB drinkers” class (OR=8.66; 95% CI: 2.57,29.2; p<0.001), however the odds decreased when compared to the "moderate SSB drinkers" class (OR=3.85; 95% CI: 1.52,9.74; p=0.004). Socio-economic status was positively associated with class membership for those in the "average SSB drinker" class relative to the moderated and high drinker's classes (OR=1.37, 95% CI= 1.13, 1.65; p=0.001 and OR=1.41, 95% CI: 1.05, 1.89, p=0.02). However, SES was negatively associated for those adolescents classified in "moderate SSB drinkers" class and in "heavy SSB drinkers" relative to the "average SSB drinkers" (OR= 0.73, 95% CI: 0.61, 0.88; p=0.001 and OR= 0.71, 95% CI: 0.53, 0.95; p=0.02).

Regarding the individual factors, habit was positively associated with class membership for the "moderate SSB drinkers" and "heavy SSB drinkers", compared to the "average SSB drinkers" (Table 4.8). However, for those classified as "low SSB drinkers", compared to the high intake, class habit was negatively associated with class membership (OR=0.61, 95% CI= 0.43, 0.87; p=0.01). Also, those classified in the "Moderate SSB drinkers" class compared to the low intake class were more likely to have higher taste preference toward SSB intake (OR=1.13, 95% CI: 1.02, 1.25, p=0.02).

In terms of environmental factors, adolescents classified in the "moderate SSB drinkers" and the "high SSB drinkers" were more likely to have higher home availability of SSBs compared to those classified in the low intake class (Table 4.8). Moreover, adolescents classified in the high intake class had 24% higher odds of SSB school availability via vending machines than those classified in the "average SSB drinkers". However, for those adolescents classified in the "Moderate SSB drinkers" relative to the high intake class, the odds of SSB school availability from vending machines decreased by 19% (OR=0.81; 95% CI: 0.69, 0.95; p= 0.008).

Table 4.8 Three-class multinomial logistic regression with the 1-step approach using low intake class as reference

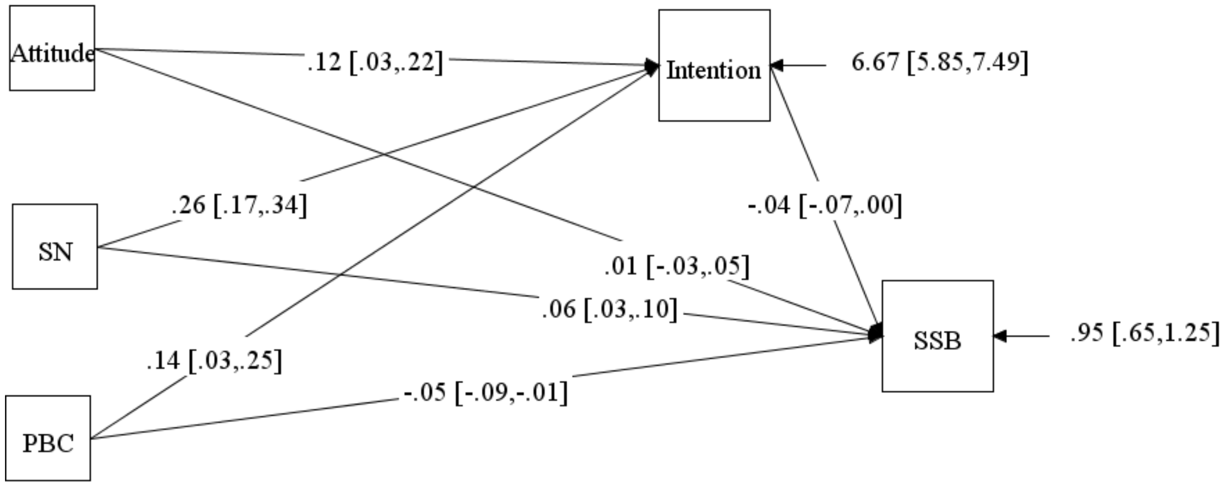
Class	Moderate SSB drinkers				Heavy SSB drinkers			
Proportion	43% (n=194)				7% (n=31)			
Parameter	OR	SE	95%CI	P value	OR	SE	95% CI	P value
Mean SSBs intake per class ml/day	1193				3339			
Gender [a]	0.26	1.6	[0.10,0.66]	0.004	0.12	1.86	[0.03, 0.39]	<0.001
Age	1.02	1.2	[0.72,1.45]	0.90	1.17	1.18	[0.84, 1.62]	0.35
BMI	0.99	1.01	[0.96,1.01]	0.23	1.01	1.09	[0.85,1.19]	0.91
SES	0.73	1.1	[0.61, 0.88]	0.001	0.71	1.16	[0.53, 0.95]	0.02
Education level	0.59	2.32	[0.11, 3.09]	0.54	0.24	3.07	[0.03, 2.16]	0.20
Intention	0.95	1.16	[0.71, 1.26]	0.71	0.93	1.15	[0.71, 1.23]	0.63
PBC	1.05	1.08	[0.91, 1.22]	0.47	0.97	1.13	[0.76, 1.24]	0.82
Habit	1.33	1.1	[1.11,1.59]	0.002	1.63	1.19	[1.15, 2.30]	0.01
Taste	1.13	1.05	[1.02, 1.25]	0.02	1.20	1.12	[0.96, 1.50]	0.11
Parental modelling	0.86	1.21	[0.59, 1.24]	0.41	0.68	1.36	[0.37, 1.24]	0.21
Peer modelling	1.10	1.15	[0.84, 1.44]	0.50	1.12	1.16	[0.84, 1.51]	0.43
Home availability	1.23	1.09	[1.05, 1.44]	0.01	1.60	1.16	[1.20, 2.12]	0.001
Home accessibility	1.23	1.17	[0.90, 1.68]	0.19	1.34	1.24	[0.88, 2.05]	0.18
School availability vending machines	1.00	1.04	[0.93, 1.09]	0.93	1.24	1.10	[1.03, 1.49]	0.02
School availability canteen	1.06	1.06	[0.95, 1.18]	0.30	1.03	1.11	[0.84, 1.26]	0.75

[a] reference is male. OR, odd ratios; SE, standard error; CI, confidence interval; BMI, body mass index; PBC, perceived behavioural control

4.3.3 Mediation and moderation analysis (RQ 3)

Mediation analysis aimed to assess how TPB constructs (attitudes, subjective norms to limit SSB intake and PBC) affected SSB intake via one hypothesised mediator: intentions to limit SSBs. Figure 4.6 displays the mediation model that was fitted to the data. The numbers between the arrows are the model estimates with all the associated standard errors (SE) in parentheses Therefore, attitudes, subjective norms to limit SSB intake and PBC were positively associated with intention to limit SSBs (paths a: γ_1=0.12, 95% CI: 0.03,0.22; γ_2=0.26, 95% CI:0.17,0.34; and γ_3=0.14, 95% CI: 0.03,0.25). However, when regressing intentions on SSB intake (path b) no association was found (β_1=-0.04, 95% CI: -0.07,0.00). Finally, the TPB constructs showed a direct effect on SSB intake (paths c': β_2=0.01, 95% CI: -0.03,0.05; β_3=0.06, 95% CI: 0.03,0.10; β_4=-0.05, 95% CI: -0.09, -0.01) after the mediator was included in the model.

Figure 4.6. Path analysis for the TPB predicting SSB intake



SN: subjective norms; PBC: perceived behavioural control; SSB: sugar-sweetened beverage intake. Numbers outside the brackets are the regression coefficient, numbers inside the brackets are the 95% Confidence intervals. The model was adjusted by age, gender, BMI, socioeconomic status and school level

The mediation analysis showed that intention to limit SSBs did not mediate the effect of attitudes, subjective norms to limit SSB intake and PBC on SSB intake as is hypothesise by the TPB (see Chapter 2, section 2.2.1). Indirect effects estimates are presented in Table 4.9.

Table 4.9 Parameter estimates of mediation of attitudes, subjective norms and perceived behavioural control on SSB intake

	Estimate	SE	P-Value
Indirect effects from attitudes to SSB via intention			
Specific indirect	-0.003	0.003	0.29
Indirect effects from subjective norms on SSB via intention			
Specific indirect	-0.005	0.004	0.22
Indirect effect from PBC on SSB via intention			
Specific indirect	-0.003	0.003	0.31

SE: standard error; SSB: sugar-sweetened beverages; PBC: perceived behavioural control

The fit of the model was poor as X^2 test was significant, (X^2 =12.0 p=0.002) the CFI and TLI were lower than 0.90 (CFI=0.89 TLI= 0.21), while RMSEA=0.04 was the only statistic with an acceptable cut-off (see section 4.2.5.3).

4.4 Discussion

This exploratory cross-sectional study examined the intake of SSBs and its associations with individual, social and environmental factors related to SSB intake in a convenience sample of Mexican adolescents, residing in a region with high prevalence of obesity. Results demonstrated that SSB intake was positively associated with habit strength, taste, home availability of SSBs and school availability of SSBs through vending machines only in adolescents in high school, whereas parental modelling was inversely associated with SSB intake. However, differences in the association of these factors were found across the different types of SSB consumers. For instance, habit was relevant only among those adolescents with high and moderate intake of SSBs, but a negative association was found for those with lower intake. Also, taste preference was an important factor only for those classified as "moderate SSB drinkers". Similarly, home availability of SSBs positively predicted the class membership of the high and moderate intake classes, while the association was inverse for the lower intake class. School availability via vending machines was positive for those in the "heavy SSB drinker", but negative for the "moderate SSB drinkers" class. Finally, there was no evidence that the TPB predicted SSB intake in this sample.

4.4.1 Sociodemographic factors associated with adolescents' intake of SSBs

Most participants consumed SSBs on a daily basis. The average daily intake of SSBs in this sample was approximately one litre per day, with male adolescents reporting considerably higher intakes than females. To support this further, the different regression analyses suggested that intake of SSBs was negatively associated in females compared to males. These findings are consistent with those from earlier literature (Bere et al., 2008; Ezendam et al., 2010; Ranjit et al., 2010; van der Horst et al., 2008; Wiecha et al., 2006) and findings from Study 1 (Chapter 3). In the current study, males appeared to have higher scores in the taste preferences, home accessibility and school availability (vending machines) scales, than females but lower scores in the intentions to reduce SSB intake and parental modelling. This may suggest that these determinants might be particularly relevant to male adolescents and should be tackled by future interventions to reduce SSB intake in this sample.

4.4.2 *Individual factors associated with adolescent intake of SSBs*

Habit strength was associated with an increase in SSB intake, which is in agreement with earlier research among Dutch adolescents (Kremers et al., 2007; Tak et al., 2011; van der Horst et al., 2007). The current study explored this further by assessing how habit strength to drink SSBs varied across different level of intake, indicating that habit strength was particularly relevant for those adolescents with moderate and high intake. This could indicate that those with moderate and high intake have created the habit to consume SSBs by repeating the behaviour several times in the past, cued by a stable context until it became automatic (Chapter 2, section 2.2.3). By this, it is possible that adolescents' habit strength towards drinking SSBs has been triggered by environmental factors, such as home and school availability (Tak et al., 2011). Therefore, future qualitative work could aid to explore the places and situations where adolescents tend to drink SSBs and whether certain contexts have the potential to trigger the intake.

According to the finding from the present study, taste preference appeared to be an important individual factor that promoted adolescents' intake of SSBs. Apart from recent evidence from the ENSANUT-2016 that referred to the taste preference to SSBs of the Mexican population, no previous evidence is available assessing whether taste preference was associated with higher SSB intake. This study addressed this gap, and the findings suggested that higher taste preferences were positively associated with higher incidence rates of SSB intake. Moreover, taste preference was a relevant factor for those adolescents classified as "Moderate SSB drinkers", but no relationship was found for those with low and high intakes. This might indicate that taste might not be an important factor to consume SSBs for low SSB drinkers, whereas for "high SSB drinkers" other factors such as habit might play a more important role. Therefore, this study also provides some evidence that the taste of SSBs might be a factor promoting adolescent beverages choices, which is in line with findings from quantitative (Bere et al., 2008) and qualitative (Battram et al., 2015; Block et al., 2013; Bunting et al., 2013; Francis et al., 2017; Visram et al., 2017) studies conducted in other countries.

4.4.3 Social factors associated with adolescent intake of SSBs

Perceived parental modelling in this sample of adolescents showed a negative association with mean SSB intake. This was somewhat expected, as modelling from parents is suggested to decrease during the late stages of adolescence (Barrett, 1996). In contrast, peers tend to have more influence on adolescent behaviours, however, none of the regression analysis found an association between peer modelling and SSB intake. This requires further investigation, as previous evidence has showed that social norms, as well as peer modelling, influence intake of SSBs (Chapter 2, section 2.3.2.2). Qualitative interviews could help to identify if peers are indeed not influencing the intake or whether other people close to adolescents are of more importance with respect to SSB intake.

4.4.4 Availability of SSBs in adolescents' settings determine intake

Home availability of SSBs has been a consistent determinant of SSB intake across the literature (Chapter 1, section 2.3.3.1). In the present study, home availability of SSBs was associated with mean intake of SSBs, but findings also showed that higher availability of SSBs at home was associated with SSB intake among those adolescents classified as moderate and high drinkers, but not those in the lower intake group. Thus, home availability appeared to have a major role promoting higher intakes of SSBs. In contrast, access to SSBs at home (at meals or during the day) showed no association with intake of SSBs. Access to SSBs at home could depend on factors that were not captured in this survey, such as household food rules and preferences of the household members. Therefore, in depth exploration of what happens at home in relation to SSB intake could help to understand what in the home environment is promoting SSB availability and how access to SSBs is operationalized in Mexican households.

In this study, school availability of SSBs from vending machines was positively associated with mean intake of SSBs. These findings are in line with those from earlier studies that also evaluated the availability of SSBs via vending machines in school's settings and adolescents' SSB intake (Hebden et al., 2013; Wiecha et al., 2006). However, the association was inverse for university students. It is important to note that schools' vending machines in Mexico tend to be accessible in private high schools and in private and public universities, but not in public high schools, whilst canteens or cooperatives (small food shops within the schools managed by school personnel) are often available in every public and private school. The lack of an association between SSB intake and canteen availability can be related with school policies, whose main target are schools' food establishments (i.e. canteens, cooperatives) (Secretaria de Gobernacion, 2014). Also, considering that more than 50% of the sample went to private schools, it may be why availability of SSBs via vending machines was relevant for this sample. This also indicates that private schools are neglecting schools' food policies by promoting SSB availability in vending machines. This agrees with a recent evaluation of the nutrition policies that suggested that private schools were less likely to adhere to food policies than public schools (López-Olmedo et al., 2018a). Moreover, the availability of SSBs in vending machines was positively associated with SSB intake among adolescents classified as "High SSB drinkers" compared to the low intake class, but inversely associated in the "Moderate SSB drinkers", suggesting that availability of SSBs is not only predicting intake but also promotes high intake of SSBs. Due to lack of evaluations of policies in schools, a further exploration of how the school context is, despite the policies, promoting the intake of SSB among their students, is needed.

4.4.5 Strength and limitations

To the best of my knowledge, this is the first study to report a combined investigation of individual, social and environmental factors in Mexican adolescents and can therefore provide the initial evidence base on which to develop future nutrition interventions to reduce adolescent intake of SSBs in high-intake areas. Also, this study used different statistical methods such as mixture models and non- linear regression models that better fit the data but also identified the factors that are more relevant depending on the amounts of SSBs consumed by adolescents.

This study, however, has several limitations. The cross-sectional design hinders the causality inferences and as the data were collected at a single time-point it was not possible to capture variation of intake due to seasonal effects [in Hermosillo the average temperature between April and September is around 29 °C, there is a decrease in temperature from October to March to 19.5°C (Servicio Meteorológico Nacional, 2018)] which might affect beverage intake patterns among the population. The use of self-reported measures to assess SSB intake and its determinants, which may lead to recall bias, is an important limitation that has previously been identified for dietary surveys (Naska et al., 2017). Moreover, this was an exploratory study using a convenience sample, which limits the external validity of the findings.

The questionnaire used to assess SSB intake has been validated in the U.S. among Latino children (Lora et al., 2016) but no validation studies have been carried out in Mexico. Nonetheless, the BEVQ was considered appropriated as it only assesses beverage intake, which helped to maintain a short length survey and permitted the used of images that facilitated responses. Also, the time scale of assessment was longer than in FFQs used for the National Health and Nutrition surveys (1 month vs. 7 day), which helped to better capture habitual intake of SSBs. Future work should validate the BEVQ in Mexico, especially among young populations, as full FFQs, 24HRs and food diaries might be burdensome, especially when the main research interest is on beverage intake.

One of the objectives of this study was to test if the TPB helped to explain the intake of SSBs in Mexican adolescents and whether habit moderated the association between intention and SSB intake. However, mediation and moderation analysis showed that intention to reduce intake was not associated with intake of SSBs and habit. This was because the intention construct was measured using one item instead of three items as is suggested in the literature (Ajzen, 2010). It has been argued that using one item is problematic as it decreases the likelihood of correctly identifying the constructs of interest (Eisinga et al., 2013). No study in Mexico was found that used the TPB to explain any behaviour, thus no previously validated measure is available to measure TPB constructs among the Mexican population. Due to this, questions used in this survey were adapted from other studies. However, incorrect measurement of intention did not allow testing of the different hypotheses. Future research should improve the measurement of TPB constructs by carefully constructing the questionnaire and conducting appropriate validation procedures.

Context cues are pre-condition of a habitual behaviour (Gardner et al., 2012b). One of the limitation of SRHI is that it fails to account for the context where the behaviour is performed (Sniehotta and Presseau, 2012). One solution proposed to overcome this involved altering the stem of SRHI by adding a specific context (i.e. Drinking SSBs at home at lunch is something I do…) (Sniehotta and Presseau, 2012). By doing so it will be possible to account for context cues and provide a better prediction of SSB intake. However, for the present study this would have involved adapting the SRHI at least three time for home and out-of-home environments including school. This mean that the SRHI would have had to be completed by adolescents three times (increasing the number of questions), affecting the length in the online survey which can lead to unreliable or incomplete responses (Gardner et al., 2012a)

The low recruitment of university students hindered the assessment of potential differences in SSB intake and its determinants between participants who attended high school and those who were university students. Also, recruitment of adolescents was higher among private, compared to public, high schools, which might limit the external validity of the study. This is because socioeconomic differences between participants might exist and variation of school environments could also impact the intake of SSBs during school hours.

4.4.6 Conclusions

In this sample of Mexican adolescents, average SSB intake was predicted by higher habit strength, taste, home and school availability of SSBs. This supports previous research on the determinants of SSB intake among adolescents. The current analysis also suggests that looking at different points in the distributions enriches the understanding of SSB intake. High intake of SSBs among Mexican adolescents was predicted mainly by higher habit strength and higher availability of SSBs at home and at school via vending machines. Further research is needed to help identify potential cues that could trigger intake of SSBs, as well as explore the home and school environments to better identify what factors within each environment are influencing SSB intake. Future intervention studies aiming to reduce high intake of SSBs among Mexican adolescents should focus on modifying these factors, by reducing SSBs availability at home and school, as well as tackling habit formation.

4.5 Thesis implications

Finding from Study 2 provided a guideline about the relevant factors that are promoting the intake of SSBs among a sample of Mexican adolescents. However, more information is needed to better understand what facilitates home and school availability, habit, and taste. To address this, a set of qualitative studies explored SSB intake at the home and out-of-home environments in depth, as well as to help identify the contextual cues that might be prompting habitual intake of SSBs in this sample of Mexican adolescents. These results are presented in Chapters 6 and 7.

Chapter 5 Qualitative Methods

5.1 Chapter overview

Chapter 4 (Study 2) indicated that the home and school environments were important predictors of SSB intake across a sample of adolescents in North West Mexico. Although the findings from Study 2 provide some indication of the importance of the role of the micro-environment in the intake of SSBs, the investigation of the home and school environments with regards to SSB intake in Mexican adolescents warrants further investigation, as the evidence base is limited and it is based on concepts from research conducted in develop countries. Thus, in-depth exploration of the different contexts that are relevant to Mexican adolescents could provide important insights into other factors that were not examined in Study 2, and that may play an important role in promoting the intake of SSBs in Mexico. In order to do so, qualitative research was chosen because it allows the exploration and understanding of life experiences and actions of the population that is being studied in-depth. Also, the humanistic attribute of qualitative inquiry permits the exploration of how people perceive experiences and beliefs about a specific issue, as well as how their interaction with others influence their attitudes and behaviours (Pitney and Parker, 2009). Therefore, by conducting qualitative research it is possible to understand the "how" of the SSB intake in different settings by exploring the actions, perceptions, beliefs and actors that surround the intake of SSBs in a sample of adolescents living in North West Mexico. Three main research questions guided the studies presented in Chapter 6, 7 and 8:

RQ 4: What are adolescents' perceptions on how the home environment might play a role in the intake of SSBs in the homes? (Chapter 6)

RQ 5: What are adolescents' perceptions on how the out-of-home environment might influence their intake of SSBs? (Chapter 7)

RQ 6: What are adolescents' perceptions and awareness of the current SSB tax? (Chapter 8)

The purpose of this chapter is to describe the methods utilized to answer the research questions outlined above. The rationale, specific research questions, results and discussion of each study are presented in Chapters 6, 7 and 8.

5.2 Mixed methods approach

As mentioned previously, due to the limited research in Mexico on SSBs it was of interest to gain a better understanding of the intake of SSB of adolescents in the Mexican context, thus qualitative methods were incorporated into this research with the aim of exploring in more depth the quantitative findings, making this thesis a mixed methods research. Mixed methods have been defined by Creswell (2015) as "an approach to research in which the investigator gather both quantitative and qualitative data and integrates the two and then draws interpretation based on the combines strengths of both set of data to understand a research problem". Among the benefits of mixed methods research is that it helps to gain deeper understanding of the findings than using only one of these method (McKim, 2017). Also, mixed method approach can increase the validity of the findings, as this approach can provide stronger evidence for a conclusion thorough the convergence and corroboration of findings (Johnson and Onwuegbuzie, 2004; McKim, 2017). Also, the use of mixed methods can answer a broader and more complete range of research questions because the researcher is not confined to a single method or approach (Johnson and Onwuegbuzie, 2004).

Within the mixed method approach there are three main designs that guide the appropriate integration of methods: convergent design, explanatory sequential design and the exploratory sequential design. For this thesis, an explanatory sequential design was chosen as the main objective was to explore in more detail the quantitative findings. The explanatory sequential design procedure is carried in four stages as shown in Figure 5.1.

Figure 5.1 Flow chart of explanatory sequential design

Adapted from Creswell (2015)

The remaining sections of this Chapter focus on the qualitative component of the mixed method approach by describing the philosophical assumptions, data collection and analysis approaches of the qualitative enquiry.

5.3 Philosophical assumptions and paradigms

Qualitative research is normally based on philosophical assumptions that shape how the problem and research questions are formulated and how we seek to answer these (Swift and Tischler, 2010). Among the philosophical assumptions are:

1) **Ontology**, defined as a person's understanding of the nature of the world (realist vs. relativist) (Swift and Tischler, 2010).
2) **Epistemology**, concerned with the theories of knowledge (objective vs. subjective) (Swift and Tischler, 2010).
3) **Methodology**, focusing on the best means for gaining knowledge about the world (deductive vs. inductive reasoning) (Denzin and Lincoln, 2011).
4) **Axiology**, concerned with the role of values in the generation of knowledge (value-laden vs. value free) (Cortés et al., 2008).

These philosophical assumptions are then clustered to form paradigms (Denzin and Lincoln, 2011; Madill and Gough, 2008). Paradigms are defined as the basic belief system or world view that guides research, not only in choices of method but also with regards to philosophical positions (Denzin and Lincoln, 2011; Saunders et al., 2009). Cortés et al. (2008) described paradigms as a way of understanding the relationships between the subject and the object; and, as a set of norms and values that guide research. According to Creswell (2013), qualitative research tend to have a relativist ontology, subjective epistemology, inductive reasoning and value-laden axiology (researcher make their values known in a study). An overview of different paradigms is shown in Table 5.1

Table 5.1 Overview of different paradigms and their relationship with the philosophical assumptions

Paradigms	**Philosophical assumptions**
Positivism and Post-positivism	**Ontology:** Realist, a single reality exists **Epistemology**: Objective, findings are true or probably true **Methodology:** deductive, experimental, tests hypotheses, quantitative methods
Critical Theory	**Ontology:** Historical realism **Epistemology:** Subjective **Methodology:** Dialogic
Social Constructivism	**Ontology:** Relativism, multiple realities are constructed through lived experiences **Epistemology:** Subjective, reality is co-constructed between the researcher and the participant **Methodology:** Inductive reasoning, qualitative methods
Pragmatism	**Ontology:** Reality is what is useful and practical **Epistemology:** Reflects both objective and subjective evidence **Methodology:** Inductive and deductive, quantitative and qualitative approaches

Adapted from Lincoln and Denzin (2011)

Considering that this is mixed method thesis, the paradigm adopted by the studies is pragmatism. The pragmatic approach emphasizes that multiple realities exist in any given problem and therefore the selection of methods will depend on the research questions (Ihuah and Eaton, 2013). The main focus of pragmatism is the problem being studied and the research questions asked about the problem.

5.4 Recruitment strategy

Participants were approached through their participation in an earlier cross-sectional online survey that was conducted between August and September 2015, which aimed to assess the intake of SSBs and its individual, social and environmental determinants among Mexican adolescents residing in Hermosillo (Chapter 4). The online survey was completed by 507 adolescents, aged 15–19 years, attending the last 2 years of high school and/or the first year of university in Hermosillo, Sonora. At the end of the survey, participants were asked to indicate their willingness to be contacted to participate in an interview. A total of 391 (77%) adolescents expressed their interest by providing an email address.

5.4.1 *Sampling*

Participants were purposively recruited to take part in an interview to achieve a sample comprising both males and females and adolescents consuming at least one portion (240ml) of SSBs per day, as previously assessed by the online survey. Adolescents who met this criterion were sent an invitation email (Appendix 13) which presented the purpose of the qualitative research, what was involved and the expected duration of the interview. To encourage participation, the invitation informed adolescents that they would be compensated for their time by providing them with $100 Mexican pesos (approximately £4) at the end of the interview. Adolescents who expressed interest (n=37) were sent an information sheet via email (Appendix 14). The study procedures were approved by the University of Bristol, School for Policy Studies Ethics Committee (SPS REC 14-15. A16) (Appendix 1). The objective was to achieve an initial medium-sized participant pool of 30 SSB consumers (Baker and Edwards, 2012) and see if saturation (point of which no new information is provided) (Pitney and Parker, 2009) was reached by then. If that was not the case, further recruitment was planned to be conducted until no new data emerged.

5.5 Interviews

The present study sought to gather adolescent perceptions, detailed description processes, beliefs and opinions. Two methods of data collection were considered: one-to-one interviews and focus groups (group interviews). Considering that the aim of the qualitative research involved the understanding of the personal contexts surrounding SSB intake such as at the home environment, and that participants who agreed to participate might come from different schools and areas of the city, conducting focus groups would have been logistically challenging. Therefore, one-to-one interviews were chosen to be the data collection method for this set of studies, as they allowed exploring issues in depth and in detail (Ritchie et al., 2014). Also, interviews were considered more appropriate than focus groups as participants were adolescents, whose opinions might be influenced by their peers. The presence of peers can represent a barrier for adolescents to talk freely about their views, or about particular situations at their homes and school environments (Peterson-Sweeney, 2005)

Qualitative interviews can have structured (no variation in the questions asked between participants), unstructured (or informal conversation) and semi-structured formats (Srivastava and Thomson, 2009). For this study, a semi-structured interview format was chosen. Semi-structured interviews consist of several key questions that help to define the topics of interest during the interview. This format is recommended when interviewing young people because it provides some guidance on what to talk about (Gill et al., 2008), but at the same time is flexible enough to allow participants to talk about things that might be relevant to them and for the interviewer to probe participants and ask additional questions if needed (Pitney and Parker, 2009).

5.5.1 Questioning guide development

To ensure that different topics regarding SSB intake were discussed with adolescents, a semi-structured questioning guide was used. The guide was developed with the objective of exploring factors associated with SSB intake, including SSB intake at different contexts, such as home and out-of-home, and perceptions of the current SSB taxation. The questions were informed by the literature review (Chapter 2) and the results from the study reported in Chapter 4. These chapters suggested that the key issues that needed to be discussed were: (1) home availability; (2) school availability; (3) the lack of evidence on the contexts that cue habitual intake of SSBs and; (4) the lack of evidence on how the current taxation of SSBs in Mexico is perceived by adolescents.

The preliminary question guide was developed in English, so it could be reviewed by supervisors and one research associate with extensive expertise in qualitative methods. Following revision to ensure that the aforementioned topics were covered, and the wording of the questions would allow participants to expand on their views, the guide was translated into Spanish and reviewed by an independent Mexican researcher to validate the translation. Then it was piloted with two Mexican adolescents within the participants' age range who did not participate in the study. Feedback from this pilot referred mainly to the wording of the questions and the formality of the interview. In light of the feedback, the questioning guide was refined, and the final version can be found in Appendix 15.

5.6 Data collection

A total of 37 adolescents (9.5% response rate), showed an interest in participating in the interviews by replying to the invitation email. Once adolescents agreed to participate in the study, a convenient for participants time and place (mainly cafes and university libraries that were of easy access to participants) was arranged to carry out the interview. If participants were under 18 years, interviews were conducted at participants' homes where an adult was in the vicinity (but not present in the interview). If the interview was conducted in public spaces different from schools, the researcher introduced the purpose of the study to the parent/carer when they dropped the participant in the agreed place of the interview. From the 37 adolescents who agreed to take part, eight cancelled or did not show up on the day of the interview. Therefore, 29 interviews were conducted in Hermosillo, Sonora, between April and May 2016. Interviews were conducted in Spanish by the researcher, who is a native from the city and experienced and trained in conducting qualitative research. The researcher has training in qualitative research and has conducted independent qualitative research in form of focus groups with young adults and one- to one interview with women. Before commencing each interview, participants were asked to read and sign an informed consent (Appendix 16).

5.6.1 Data preparation

All interviews were recorded digitally with an encrypted Dictaphone (Olympus, DS-3500) and were stored in a secured folder on the University of Bristol network. All interviews were then transcribed verbatim by the researcher and anonymised by assigning a participant number to each interview. All transcripts were checked against the recordings to verify accuracy and credibility and small changes were made where necessary. The interview transcripts were then imported into N-Vivo (Version 10, QRS International Pty Ltd, UK) for analysis.

5.7 Selection of Analytical method

Considering that this set of studies are based on a pragmatic approach, a number of analytical methods could be used to address the research questions (Creswell, 2013). Given that the objectives of this set of studies was to explore the multiple contexts or environments (including the current tax policy context) that could influence the intake of SSBs in this sample of adolescents, thematic analysis was considered to be the most appropriate method to analyse the data, compared to other analytical methods such as grounded theory, ethnography, phenomenological analysis and discourse analysis. This was mainly because the studies' objectives were not compatible with the aims of other analytical approaches (i.e. generate a theory, describe a culture, discover the essence of the phenomenon, or analyse the language use by individuals). Thematic analysis is also mainly characterized by its flexibility as it is independence from theory, which allows its applicability across different theoretical and epistemological approaches (Braun and Clarke, 2006). Thematic analysis provides an accessible and systematic procedure to search and generate themes or patterns across the data set (Clarke and Braun, 2017).

Since the aims of these studies included the exploration of different settings where Mexican adolescents consume SSBs, it was important to choose a method that permitted to account for similarities and differences between participants, but also across different settings. Thus, the framework approach was selected to guide the data management and analysis process. The framework approach is an analytical tool that sits within thematic analysis (Madill and Gough, 2008; Ritchie et al., 2014). It specifically incorporates thematic analysis' core skills, such as coding and defining themes, but additionally provides a systematic guideline of how to sift, chart and sort material based on the key themes (Guest et al., 2012). Moreover, thematic framework analysis facilitates comparisons by allowing moving back and forth across the data set until a coherent interpretation of the phenomenon under study is reached, while maintaining a link with the original data (Ritchie and Spencer, 2002). This is achieved through the construction of framework matrices, where themes and subthemes are organized in column headings, with the first column used to accommodate cases and demographic characteristics of the sample. A summary of each theme or subtheme by case is presented in the matrix, along with raw data that might be of importance for the interpretation of the findings. However, a limitation of the thematic framework approach is that the use of matrices to manage the data could prompt the researcher to quantify the qualitative data (i.e. 15 out of 29 participants agree on *X*) which can affect the depth of the analysis. To overcome this, efforts were made, throughout the analysis, to avoid quantifying the data, and in turn the focus was placed on developing a true understanding of participants' views on how the intake of SSBs is performed under certain contexts and social circumstances, by examining data from multiple participants with different characteristics (age, gender, education) and associated perspectives.

5.8 Data analysis

Data analysis was carried out in Spanish, the original language of the interviews. Conducting the analysis in the original language is recommended (Al-Amer et al., 2016, 2015) as translating each of the transcripts into English for its analysis could have an impact the data and thus the trustworthiness of the results. Translating interviews is not only time consuming but it is also expensive, as an adequate translation process would require carrying back and forward translation (translate from Spanish into English and then back translate from English into Spanish by independent translator), this in order to validate the translation (Al-Amer et al., 2015; Esposito, 2001; Temple and Y, 2006). However, it has been argued that good translation alone is not enough to provide textual and content equivalence of the original text as translating the transcripts into English could be subject to loss of meaning of some expressions and slang that are bound to the Mexican culture, regional difference and the participant's social context (Al-Amer et al., 2016; van Nes et al., 2010).That is why conducting the analysis in the original language or delaying any translation is recommended as prevent the loss of misinterpretations of participants' statements (Al-Amer et al., 2015; Birbili, 2000; Lincoln et al., 2016; van Nes et al., 2010).

However, themes and quotes were translated into English by the researcher who conducted the interviews, who is a native Spanish speaker, and back-translated to Spanish by an independent bilingual researcher (Birbili, 2000; Esposito, 2001; van Nes et al., 2010) in order to check for the accuracy of the translation (as the thesis is being examined English, just the English translation are included in the text).

The thematic framework analysis was conducted in five stages (Gale et al., 2013; Ritchie and Spencer, 2002). The first stage involves the familiarisation with the data. This started during the transcription of the interviews, which was the first opportunity to become immersed in the data, and also helped to begin recognizing pieces of information that could be useful for later analysis. This was followed by reading transcripts repeatedly and taking notes of recurrent topics, as well as areas of interest that could help to answer the research questions.

The second stage of the analysis was coding. The objective of this stage is to simplify the data, to make it easier to compare with other parts of the data set, and in the case of the framework approach, it contributed to developing an initial coding frame (Gale et al., 2013). Coding consisted of reading the transcripts line by line and applying a label to any piece of text that might be important to the aims of the study (Gale et al., 2013). The coding process was both deductive and inductive, where most codes were data driven and a few codes were predetermine by the findings from Study 2 (see Table 6.2 and 7.2). In order to validate the coding process, two trained researchers (the PhD applicant and another Mexican researcher) independently coded 10% of the transcripts (three interviews). A number of meetings were then held to discuss the coded sections and any coding discrepancies (e.g. differences in terminology used by the coders and whether codes were useful to answer the research questions).

The third stage involves the development of a working analytical framework. Both coders agreed on a set of codes that formed an initial framework, consisting of 53 codes. Using the initial framework, three more interview transcripts were independently coded, taking into account any new themes, codes and nuances. The two coders met again to refine the initial framework by incorporating new codes. The final analytical framework was comprised of 83 codes. Inter-coder reliability was 95%, as assessed by dividing the number of agreements by the sum of agreement and disagreements.

The fourth stage of the analysis was indexing, which consists of systematically applying the framework to all transcripts. This process was carried out by the PhD applicant using NVivo (Version 10, QRS International Pty Ltd, UK). If new information emerged that was not part of the final analytical framework (developed in the third stage of the analysis), a new code was assigned. Before clustering the codes into themes, the analysis was segmented into three phases, where each phase accounted for each of the three research questions presented in Section 5.1. The first phase involved clustering codes in themes that related to the intake of SSBs in the home environment. The second phase focused on clustering codes in themes that reflected the intake of SSBs in the out-of-home environment. Finally, the third phase focused on clustering codes into themes related to the adolescents' perceptions and attitudes towards the SSB taxation policies.

The fifth and final stage of the analysis was charting. This aimed to manage and reduce data by rearranging raw data into charts or framework matrices. N-Vivo was used to create the different thematic matrices for each of the analytic phases. A total of four matrices were constructed and were exported to Microsoft Excel for better handling. The first column of each matrix was used to display participant numbers and demographic information (i.e. age, gender, type of school), while the subsequent columns displayed raw data from the interviews and summaries made by the researcher in relation to each of the themes (Appendix 17). Arranging the data in this way facilitated the examination of the data case-by-case, but also allowed the comparison of perceptions, experiences and attitudes across participants and across themes (Gale et al., 2013). This is of great importance, especially when exploring participants' views on the school environment, where comparisons based on the type and level of education informed variations in the data.

In the results sections in Chapters 6, 7 and 8, emerging themes are illustrated by representative quotations from participants, indicated by participants' characteristics: male/female, and age in years. Quotations in Chapter 7 are additionally indicating the type of school (private/public) and education level (high school/university), this in order to compared quotes among adolescents according to their schools. The quotes were selected to best reflect the diversity of responses.

5.9 Qualitative rigour

Lincoln and Guba (1985) first introduced the term trustworthiness as a way of expressing validity and reliability of the findings in qualitative research. Thus, concepts like credibility, transferability, dependability and confirmability are normally used in qualitative research. The following sections provide a description of each of these terms, followed by the techniques used to achieve trustworthiness during the analysis and the writing up of results of the current studies.

5.9.1 Credibility

Credibility in qualitative research relates to the extent findings are congruent with reality (Lincoln and Guba, 1985; Shenton, 2004). In these studies, credibility of findings was sought by members' checking, peer debriefing and analyst triangulation. Member checking, or respondent validation, involves checking the accuracy of the data by asking participants their views on what they previously said during the interviews, in order to assess if their words match with what they actually intended to communicate (Shenton, 2004). In the current studies, member checks were achieved by providing a brief summary of the discussion to each of the participants at the end of the interviews. Participants were then asked if that summary was correct and if they wanted to add something or made any correction to it. There were some cases where participants extended on some aspect of the interview by providing more detailed information.

Peer debriefing involves receiving feedback on the research process from independent researchers (Lincoln and Guba, 1985; Shenton, 2004). For the current studies, regular meetings during the data analysis were held with academic supervisors who acted as debriefers. This was an opportunity to discuss the development of themes, where they were able to provide their critical input on how data was being interpreted and highlight any possible bias or misinterpretation of findings. Finally, analyst triangulation refers to using different investigators to analyse the same qualitative data (Patton, 2002). This helps to reduce the potential bias of a single person conducting the data analysis (Patton, 2002). To achieve credibility of the data analysis for these studies, two independent researchers coded and contributed to the construction of the coding framework, as described in section 5.7.

5.9.2 *Transferability*

In qualitative research, generalizability of the findings is not a goal, instead transferability is the extent to which findings of a specific piece of research applies to other situations in similar communities or contexts (Pitney and Parker, 2009). To achieve transferability for this set of studies, a rich description of participants' characteristics and context in which field work was undertaken is presented throughout the result sections presented in Chapters 6, 7 and 8.

5.9.3 *Dependability*

Dependability is the equivalent to reliability in quantitative research, and its aim is to ensure that that the research process is logical and traceable (Tobin and Begley, 2004). Dependability of this research was reached by providing an in-depth description of the methods used, to allow repetition of the studies.

5.9.4 *Confirmability*

Confirmability aims to ensure that the findings' interpretation is derived from participants' experiences and ideas, rather than the researcher's characteristics and preferences (Shenton, 2004). To achieve confirmability, it is important to provide a transparent account of the processes followed during data collection and analysis and a clear justification for favouring specific approaches, which has been the main objective of this chapter. Moreover, it is recommended that the researcher admits his or her own predispositions. This was achieved through a reflective commentary presented in section 5.9.

5.10 Reflexivity

Ideally, researchers should remain neutral and avoid obvious, conscious, or systematic biases in the collection, interpretation, and reporting of findings (Creswell, 2013). However, in qualitative research this is often difficult to achieve, as other published work or researcher's own work can bias the findings and/or their interpretation. To address these issues, it is recommended that researchers acknowledge any sources of bias, as well as values and experiences that they might bring to the research. The following section presents my reflections on these issues:

I feel that it is important for the reader to understand the motives encouraging the investigation on this topic. Since I was an adolescent myself, I understood that drinking SSBs was something unhealthy to do and a potential cause of diabetes (a common disease in my family). I attribute this in part to my mother who always made sure to limit the amount of soda consumed during meals at home and procure the availability of a range of beverage options different from soda, especially the preparation of aguas frescas with fresh fruit and low sugar content. At the time, I was also training to become a ballet dancer, which encouraged me to maintain a healthy diet, therefore limiting carbonated SSBs was a natural step. At the end, my ballet career could not be consolidated and instead I chose to pursue a career in nutrition with the intention to guide people towards a healthy diet, something I was exposed to since a very early age.

After I finished my studies in nutrition and food science, I worked as a dietitian in national and local institutions in Mexico. I also had my own practice in the city of Hermosillo, where I mainly worked with overweight and obese patients. Through this experience, I began to recognise the role that SSBs played in the diet of adults. Here I noticed the high consumption of SSBs, particularly Coca-Cola, and the challenges that patients faced when trying to reduce their consumption. However, I also noted that those patients who were able to reduce the intake of SSBs manage to lose weight easier during the first weeks, compared to those who struggled to limit SSBs. This led me to question, why it is so difficult for people to reduce their intake of SSBs? Just prior to coming to Bristol to pursue my postgraduate studies, I worked as the nutrition manager in a local public health *programme to prevent and control non-communicable diseases through diet and physical activity. Here again I encountered the problem of SSB consumption, but this time in the context of diabetes.*

My work experience provided me with knowledge about the difficulty that is to make people reduce their intake of SSBs. The experiences across my professional career, together with the lack of research on the determinants of the intake of SSBs in Mexico, have guided the research project. For instance, having grown up in the same city as the participants in this research was of great assistance during the design and throughout data collection. When I designed the study, I had in mind how feasible thing were by considering issues that had to do with the weather, transport, schools and the lack of exposure the city has to research and how this could hinder the participation of schools and adolescents. Also, the questioning guide was developed bearing in mind what it is like being an adolescent in Hermosillo, which permitted to account for the physical, social and cultural structure of the locality. During the interviews, my experience as a dietitian helped me to not be judgemental of participants' beverage intake and to give them confidence to talk freely about different aspects of their diet, as well as other aspects of their life. Upon data analysis, I did my best to separate myself from my experiences and previous knowledge of the topic and to just focus on the data. However, it was difficult to fully detach myself from previous knowledge and during the coding process I tended to use names or concepts from the literature, instead of using data driven codes. Having a second coder was of great help with this as he pointed out my usage of terms from the literature which could have introduced bias to the interpretation of the results.

5.11 Chapter summary

Overall, this chapter described the data collection process and provided a rationale for sampling and the selection of analytical methods. Also, it describes how qualitative rigour was achieved for this set of qualitative studies. Thematic framework analysis is used to analyse the interview data in order to answer the research questions of the following three chapters.

Chapter 6 Study 3: The role of the home environment in sugar-sweetened beverages intake among northern Mexican adolescents

6.1 Chapter Overview

The finding from Chapter 4 demonstrated that home availability of SSBs was associated with the intake of SSB in a sample of Mexican adolescents, and that home availability was positively associated with moderate and high intake of SSBs but negatively associated with those with lower intake. Although, the findings from Study 2 are the first results in Mexico to indicate that the home environment might play an important role on the intake of SSBs, the evidence provided by the online survey is still limited as only two concepts regarding the home environment (home availability and accessibility) were assessed. In other words, the survey did not capture how the availability and the accessibility happen at the household, or if there were other home related factors that might be relevant for adolescents' intake of SSBs. This is important, because identifying these factors could reshape the current understanding of SSB intake at home and could redirect current and future efforts to reduce intake in Mexican youth.

As previously discussed in Chapter 2, there is a body of evidence that emphasize the role of home environment in the intake of SSB among adolescents. Quantitative evidence has suggested that factors such as the availability and accessibility of SSBs, family meals, parental modelling, parenting practices and family food rules have been positively associated with the intake of SSBs among children and adolescents residing in developed countries (Bere et al., 2008; Bogart et al., 2017; Ezendam et al., 2010; Grimm et al., 2004; Hebden et al., 2013; Tak et al., 2011; van der Horst et al., 2007; Van Lippevelde et al., 2013; Verzeletti et al., 2010). On the other hand, qualitative studies in the U.S. and Australia have explored home environmental facilitators of SSBs, indicating that home availability and adult purchasing of SSB were the main facilitators of SSB at home (Bogart et al., 2013; Hattersley et al., 2009). Although the findings from quantitative and qualitative studies provide an important insight into the factors that influence SSB intake at home in developed countries, less is know if other factors, apart from home availability, are also relevant for Mexican adolescents.

Results from Chapter 4 also indicated that habit strength was also associated with adolescents' SSB intake, which suggests that SSB intake could be a habit-triggered behaviour. As described in Chapter 2 (Section 2.2.3), habit is process by which a stimulus, in form of environmental or contextual cues, automatically generate and impulse toward action (Gardner, 2015). By conceptualizing SSB intake as habitual behaviour, it is likely that this habit has been formed through context-dependent repetitions. However, less is known about which contexts or under which conditions habit of consuming SSB is triggered (e.g. home, school, other places), given that the index utilized to measure habit strength in Study 2 did not capture the context were habitual behaviours was performed. Therefore, identifying the different contexts in which the habit of drinking SSBs might be triggered could be useful in the design of future interventions that aim to reduce SSB intake in Mexican adolescents, by focusing in changes in the home environment.

6.1.1 Aims and Research Questions

Overall, the there is some evidence that indicates that home availability and habit are predictors of SSB intake in this sample of adolescents. An issue, however, is that little is known about how home availability of SSB carried out in the household, which leads to the first aim of this study that is to explore home availability of SSBs in adolescent's households. The second aim involves the identification of other factors in the home environment that might as well promote the intake of SSB of adolescents in the home environment. Finally, considering that habit appeared to predict intake of SSBs and that habitual behaviours are triggered by stable context or situation, the third aim of this study involved, based on participants accounts, the identification of circumstances at the home environment that might triggered SSB. This study will answer Research Question 4 of this thesis:

RQ 4: What are adolescents' perceptions on how the home environment might play a role in the intake of SSBs in the homes?

RQ 4.1: What are adolescents' perceptions on the availability of SSB in their homes?

RQ 4.2: Are there other factors within the home environments that are promoting SSB intake among Mexican adolescents?

RQ 4.3: What are the potential contextual cues in the home environment that trigger SSB intake among a sample of Mexican adolescents?

The methods used to answer these research questions are describe in detail in Chapter 5.

6.2 Results

In total, 29 adolescents (16 females, 13 males, ranging in age between 15 and 19 years [mean=17.0; SD=1.4] participated in the interviews. Detailed personal characteristics are presented in Table 6.1.

Table 6.1 Sociodemographic characteristics of the sample and mean daily intake of SSB

Participant information	Mean/ %	SD/n
Age (years)	17	1.3
Body mass index (kg/m^2)	22.3	4.4
SES (0 –10) [a]	5.6	2.5
Living situation		
Living with parents/family	100	29
Living alone	0	0
Living with friends	0	0
Education level		
High school	75	22
University	24	7
Type of education		
Public	38	11
Private	62	18
Mean daily intake of SSBs (ml/day)		
Sweetened juices/ fruit drinks	368.3	442.7
Regular soft drinks	189.3	169.2
Aguas frescas	325.7	419.6
Sweetened iced teas	259.5	376.6
Coffee and/or tea, with sugar	242.4	278
Sport and energy drinks	256.6	419.6
Total SSBs	1020.8	1297.6

BMI, body mass index; SES, socio-economic status. [a] SES scores ranged from 0 to 10, with 0 indicating the lowest and 10 indicating the highest SES.

On average, participants had a normal body mass index (BMI) and came from a middle socio-economic status (SES). Also, all participant lived with parents or family members. In contrast with other countries, adolescents and young people in in Mexico who are over the age of 18 do not necessarily leave the parental home when they start higher education or employment. In Mexico, is sometimes common to live with parents until marriage. There is evidence suggesting that the 61% of young people over the age of 24 years in Mexico live in their parental home (Echarri Cánovas and Pérez, 2007) whereas in the UK 25% of young people over 20 to 34 years have not left their parental home (Office for National Statistics, 2016). The majority of participant were attending to high school and to either a private. The mean SSB intake was 1,020 ml/day where the sweetened juices and aguas frescas were the most consumed beverages. A total of five themes resulted from the data analysis, this are presented in **Table 6.2**.

Table 6.2 Resulting themes and subthemes that explore SSB intake in the home environment

Themes	Subthemes	Nature of the codes
Context of SSB availability at home	Home availability	pre-determined
	Limited availability	
	Family roles for purchase and preparation	emergent from the data
	Decision-making	
Facilitators of SSB availability at home	Ease of purchase	emergent from the data
	Aguas frescas/juices 'health halo'	
	Taste preference	
Perceived importance of having SSB at home	Food intake	emergent from the data
	Taste	
	Sugar craving	
Role of family in SSB intake at home	Family health awareness	emergent from the data
	Family preferences	pre-determined
	Family rules	emergent from the data
	Family influence	emergent from the data
SSB intake as habitual behaviour in the home environment	Habits and family norm	pre-determined
	Cue-eating occasions	emergent from the data
	Cue-availability	pre-determined

6.2.1 Context of SSB availability at home

The presence of SSBs was something common in adolescents' households, as nearly all participants mentioned that different SSBs were available at home. Very few participants mentioned not having SSBs in their homes and referred only to the accessibility of other beverages, such as water, milk and non-caloric powdered beverages:

> "*There is always iced tea in my house; also, there are always juices"* (P16/Female/16 yrs.)

"We always have juice at home, soda and iced tea" (P18/Male/17 yrs.)

The availability of SSBs at household level varied across participants and was either through purchase or home preparation. SSB purchases were generally made at the supermarket during the weekly grocery shopping or every day in shops near home:

> *"Beverages are normally bought in the shop near the house, because it's the fastest."* (P13/Male/19 yrs.)

> *"We buy beverages when we buy the groceries."* (Q4/P27/Female/16 yrs.)

The role of parents, especially mothers, was of key importance since they were commonly in charge of buying or preparing SSBs on a daily or weekly basis:

> *"My mom is the one who takes care of it; normally when she goes to the supermarket she buys them [SSBs]."* (Q5/P24/Male/17 yrs.)

> *"My mom is the one who goes to the supermarket and makes the beverages."* (Q6/P15/Female/19 yrs.)

To a lesser degree, fathers also played a role in the availability of SSBs at home:

> *"My dad, it's like he says: 'Mm a soda' or 'we need iced tea'. It's because he likes sweet things."* (Q7/P28/Female/17 yrs.)

> *"Sometimes my dad arrives home with sodas and so on, to mess up with the order."* (Q8/P15/Female/19 yrs.)

In a few cases, purchasing and preparation of SSBs was a split between all family members:

> *"We take turns; sometimes my brother buys them, or I buy them or my mom."* (Q9/ P27/Female/16 yrs.)

Decision-making processes about beverage availability mostly involved all household members, but the parents were normally the ones responsible for purchasing them. This indicates that agreements regarding what beverages are available at home did not necessarily depend on one family member, and that the different beverage preferences were considered by the parents prior to purchase:

> *"Well, we all decide, but they [parents] are the ones who buy the groceries right now and we get what they buy. But if I say: 'I want this to drink', they will buy it."* (Q10/P11/Female/19 yrs.)
>
> *"It's rather by majority of votes."* (Q11/P25/Female/17 yrs.)

However, some adolescents thought that their parents were the ones who decided what types of beverages would be available to them in the household:

> *"Indirectly the decision is on them [parents], because they buy three types of drinks for the house; each of us chooses what we are going to drink, but they are the ones who buy them [SSBs]."* (Q12/P13/Male/19 yrs.)
>
> *"It's almost always my dad who decides."* (Q13/P17/Female/15 yrs.)
>
> *"My parents decide together what is going to be available to drink... they never ask."* (Q14/P1/Male/15 yrs)

6.2.2 *Facilitators of SSB availability at home*

Home availability of different SSBs seemed to be affected by three different factors. One that facilitated the availability of fruit-containing beverages or fruit-flavoured drinks, independent of sugar content, at home was the perception that these were healthier than artificially flavoured drinks (also known in previous literature as juice's "health halo") and thus they were considered an acceptable beverage to have at home. This seemed to favour the intake of *aguas frescas* and sweetened juices. Preferring *aguas frescas* over other beverages, including water, was reported as a way to improve diet, and this was achieved through a shift from industrialised to home-made SSBs:

> *"It's not natural juice but it's better than the soda."*
> (Q15/P18/ Male/17 yrs.)

> *"If we drink Jamaica [hibiscus water] it's with brown sugar; my family try to make beverages healthy, and it's like 'let's not drink soda.'"* (Q16/P2/Female/15yrs).

> *"Because I'm drinking a beverage that does not contain gas, and according to me it's not as harmful as Coca-Cola."*
> (Q17/P4/ Male/16 yrs.)

Second, the availability of bottled SSBs at home was facilitated by the ease of buying them compared to preparing beverages (referring mostly to *aguas frescas*). Buying bottled SSBs was perceived as a good alternative when there was no time to prepare "healthier" beverages:

> *"It is faster to buy soda than to prepare a beverage."*
> (Q18/P19/Male/18yrs).

> *"If they don't have time to make lemonade they buy something ... if there is nothing to drink we go to the [mini-market name] and buy flavoured sodas. That's what we buy when we don't have time."* (Q19/P29/Female/16 yrs.)

Third, taste preferences for SSBs also appeared to promote their availability at home. Adolescents perceived that they and their family members had a strong preference SSBs, thereby facilitating availability due to their high acceptance among members.

> *"I say they [family] drink soda because they like the taste of it, because they drink [soda brand] and they like its taste.*

When they change to juices or lemonades and flavoured waters it is also because of the taste. They get fed up with one flavour and then change to another flavour, but it is the taste, I would say." (Q20/P13/Male/19 yrs.)

"My brother says it's really tasty and, according to him, he cannot stop drinking [soda]. I think it is because it's sweet and because it's sparkling. (Q21/P28/Female/17 yrs.)

6.2.3 *Perceived importance of having SSBs at home*

Many participants believe that having SSBs at home as something important:

"It's very important, because if there is no soda it's like not eating; we stop feeling hungry…if there is no soda it's like someone needs to go and buy some, otherwise we don't eat." (Q22/P18/Male/17 yrs.)

Adolescents who thought it was crucial to have SSBs at home reported taste and sugar cravings as important reasons:

"I'm the one who gives priority to that [SSBs] because of the taste, because I like the sweetness." (Q23/P20/Male/17 yrs.)

"Sometimes when I'm craving something sweet I drink juice." (Q24/P6/Male/16 yrs.)

Nonetheless, the most prevalent reason was that SSBs complemented food intake. Nearly all participants emphasized the importance of accompanying food with sweet drinks, rather than plain water:

" Drinks [SSBs] are to accompany food, we never drink water with food." (Q25/P13/Male/19 yrs.)

"Well, yes, I mean with sweet beverages you can better accompany food and they are tastier." (Q26/P19/Male/18 yrs.)

Carbonated beverage intake was particularly linked, with Mexican dishes (e.g. tacos) and fast food (e.g. pizza or hamburgers), whereas iced tea and *aguas frescas* were linked with salads or dishes considered to be "healthier":

"Well, if it is junk food, like maybe pizza or something like that, it's generally with soda". (Q27/P23/Male/16 yrs.)

"…for example, when they prepare tacos dorados [fried tacos], if it's more Mexican, it's better with Jamaica [hibiscus water] or something like that, you know… There is one dish that is perfect with [soda brand]; I believe it is the tortas [Mexican sandwich] that my mom prepares; I mean those need to be with Coca-Cola." (Q28/P2/Female/16 yrs.)

"Salads from [local restaurant name], for instance, are with [iced tea brand] or Jamaica [hibiscus water] or lemonade, something like that." (Q29/P28/Female/ 17 yrs.)

"Salads and all that are with [iced] tea, meats with soda… and Mexican dishes are with soda, too." (Q30/P3/Male/16 yrs.)

Nonetheless, for some participants it was not important to have SSBs at home, but they explained that their families were the ones who considered it important:

"To them it's important, but it isn't to me. For them it's something that is always needed, and if there are none they buy or prepare them [SSBs]." (Q31/P28/Female/17 yrs)

"Well, for me it's not [important], but they like them [SSBs] a lot… I don't know, they are used to drinking them [SSBs]." (Q32/P11/Female/19 yrs.)

6.2.4 The role of family in SSB intake at home

All adolescents in this sample lived with their parents and/or other family members. It was therefore essential to explore adolescents' perceptions of how their families' preferences and behaviours regarding SSBs might play a role in their own intake of SSBs at home. First, as mentioned previously, preferences for SSBs were evident among parents and family members:

> *"My dad likes to drink root beer… I associate [soda brand] with my mom because it's the only thing she drinks."* (Q33/P26/Female/17 yrs.)

> *"My dad likes to drink coffee or Jamaica [hibiscus water]; she [mom] drinks water or soda, but she also drinks Jamaica [hibiscus water]."* (Q34/P22/Male/17 yrs.)

Participants also indicated that one or more of their siblings also had certain preferences towards drinking SSBs:

> *"My brother does not like water, and, for example, if there is Jamaica [hibiscus water] he will have a bottle of iced tea; he buys it and he drinks it all the time."* (Q35/P29/Female/16 yrs.)

> *"My sister likes iced tea a lot, she likes [iced tea brand], either the peach or lemon one, it doesn't matter which."* (Q36/P21/Male/18 yrs.)

Some participants also mentioned other family members, such as grandparents, aunts and uncles, and their preferences toward SSBs. They cohabited in the same house, lived close or visited their homes often. This indicates that relatives other than parents and siblings can also influence the consumption of SSBs:

> *"My grandparents are coffee drinkers and whenever I go to their home they make iced tea for lunch; then I started to*

drink sweetened tea and then coffee with sugar and then I started to do the same in my house" (Q37/P24/Male/17 yrs.)

"You know what influence me a lot? That we are always with my aunt. My mom and my aunt are always drinking coffee with sugar, or they are like 'we are craving soda' and they buy and buy" (Q38/P27/Female/16 yrs.)

A few participants stated that the preference for SSBs was a family thing:

"It's because everyone likes [soda brand]; therefore, there will always be some [soda brand]" (Q39/P25/Female/17 yrs.)

"They [family] drink soda for breakfast, lunch and dinner, and coffee too" (Q40/P18/Male/17 yrs.)

"The [soda brand] is the one that is very familiar; my dad drinks it; my mom drinks it and I ended up drinking it" (Q41/P5/Male/17 yrs.)

Participants largely perceived that family members influenced the intake of SSB at home by facilitating the availability of SSBs and by drinking SSB with them as part of shared activities

"But what also influence me in my house that my brother and my mom buys soda all the time and I see it [soda]; and it's not just for the simple fact that I crave it [soda], but I drink it because I see it there." (Q42/P27/Female/16 yrs.)

"I tend to drink soda when I'm with my dad." (Q43/P12/Female/18 yrs.)

6.2.4.1 Parental regulation and SSB intake at home

Within the 'Role of family in SSB intake at home' theme, parental regulation seemed to be an important factor contributing to adolescents' SSB intake at home.

Most participants expressed that they were free to drink SSBs at home and that there was no rule preventing them from doing so:

> *"They have never banned any beverage or said, 'Drink this.'"*
> (Q44/P28/Female/17 yrs.)

> *"My mom doesn't restrict them [SSBs]; well, I believe that she has never told me 'Don't drink something."*
> (Q45/P9/Male/17 yrs.)

Others mentioned that some rules on SSBs and their availability at home existed. These restrictions seemed to be influenced by the level of health consciousness among the parents:

> *"My dad gets worried that I drink a lot of sugar and he always tells me '[participant's name], you drink a lot of sugar', so when I go to his house he won't allow me to drink anything with any sugar."* (Q46/P27/Female/18yrs).

In some cases, limiting of the home availability of SSBs was the result of parents trying to lose weight or having a health condition, such as diabetes:

> *"Before, we used to drink a lot of [soda brand]; we did not buy many juices, but then my dad came out diabetic and we stopped buying; well, we stopped buying so much [soda brand]. Before, it was like three litres of soda a day, but since my dad has been sick, we have stopped drinking that much [soda brand]."* (Q47/P17/Female/15 yrs.)

> *"Well, my mom has always been on a diet eating salads and all that, and she tries to never buy [SSBs]."*
> (Q48/P8/Male/19 yrs.)

In households where there were efforts to reduce SSB intake, some inconsistencies in maintaining healthy beverage habits over time were nevertheless highlighted by adolescents:

> *"Mm, they used to say that [SSBs] are very bad, and in my family, they stopped drinking it and then they would drink it again."* (Q49/P13/Male/19 yrs.)

> *"My mom says: 'We already drink lots of soda; we are going to drink lemonade or Jamaica [hibiscus water], because we already drink a lot of soda and we have to stop', and then we stopped for like two weeks only."* (Q50/P22/Male/17 yrs.)

6.2.5 SSB intake as habitual behaviour in the home environment

For some adolescents, drinking SSBs at home was regarded as habitual behaviour. For instance, some participants explained that drinking SSBs was a family habit, something they were used to do or something that was common because their families had done it for many years or for as long as they can remember:

> *"Soda is a habit of my parents, they got me used to it; it's innate ... it is how we were imposed; I do not know how this happened. I remember there was always soda or some type of sugary drink."* (Q51/P12/Female/18 yrs.)

> *"It could be a habit because it's what we have always drunk."* (Q52/P19/Male/18 yrs.)

Also, some adolescents thought that the constant home availability of SSBs throughout the years had led them to form a habit of consuming SSBs:

> *"It's always the same, so it's like we got used to drink the same."* (Q53/P16/Female/16 yrs.)

"I remember that soda has always been available"
(Q54/P12/ Female/18 yrs.)

One of the components of habit is automaticity (Verplanken and Orbell, 2003). Automatic processes are unconscious, that is no mental effort is applied and therefore they tend to be fast (Moors and De Houwer, 2006; Orbell and Verplanken, 2010). According to some participants the decision to drink SSBs at home was fast, possibly indicating some degree of automaticity. Participants also mentioned that the speed of their choice would depend on what types of drinks were available:

"It depends on what is there; if it's my favourite drink or one of my favourites, it's fast. If there are many drinks that I like, I'm slower to decide because I crave them all."
(Q55/P2/Female/16 yrs.)

"Well, I ask my mom what she prepared, if not I just drink juice." (Q56/P5/Female/17 yrs.)

"At home it's fast, because I have juice and that is what I'm going to drink." (Q57/P6/Male/18 yrs.)

6.3 Discussion

This study qualitatively explores the factors surrounding SSB intake in the home environment among a sample of adolescents living in an urban area in North West Mexico. Five emerging themes help to describe the role of the home environment on adolescents' intake of SSBs: 1) Context of SSB availability at home; 2) Facilitators of SSB availability at home; 3) Perceived importance of having SSBs at home; 4) Role of family in SSB intake at home; and 5) SSB intake as habitual behaviour in the home environment. These findings highlight a number of barriers for current policies, but also present a number of opportunities for future interventions directed to the reduction of SSB intake among Mexican adolescents.

Previous evidence presented in Chapter 4 has suggested that home availability of SSBs is associated with the intake of SSBs in adolescents. The findings from the current study explained more profoundly how this correlation might occur due to potential facilitators of home availability in Mexican households. For instance, the belief that fruit-containing beverages, such as fruit beverages and *aguas frescas*, are healthy and therefore good to drink, was prominent among this sample of adolescents. Block et al. (2013) first introduced the term "health halo" to refer to young adults' beliefs with regards to the health benefits of juice. Earlier qualitative studies among Mexican children and Latino adolescents and their parents also emphasized the notion about the "healthfulness" of *aguas frescas* because of their fruit content and natural ingredients (Bogart et al., 2013; Theodore et al., 2011). Although the preparation of *aguas frescas* is more "natural" compared to other industrialised beverages, this "health halo" is likely to hinder adolescents' capacity to question what they drink, and therefore requires attention. For example, the sugar content of *aguas frescas* is sometimes not acknowledged, as the amount of sugar in these beverages is subjective and based on an individual's taste during preparation. This suggests that looking at the sugar content of these beverages and identifying ways to reduce the amount of sugar added in home-made drinks could be a viable public health intervention. It is also important to recognise that the amount of sugar in these home beverages would not have been affected by the recent changes in SSB prices in Mexico, as the taxation only applies to bottled SSBs and not to home-made SSBs. Moreover, as suggested by Theodore et al. (2011), beverage marketing in Mexico has contributed to the belief that fruit juices or other industrialised fruit-flavoured and fruit-containing beverages are "healthier". Educational strategies are therefore needed, not just for adolescents, but also for family gatekeepers, in order to inform the public about the sugar content of fruit beverages, as well as healthier preparation of home-made beverages, and to promote water as the healthiest beverage of all.

Food intake, especially during lunchtime, seemed to be a facilitator of SSB intake. This shows how embedded routine and family practices can be and is also consistent with previous findings from a qualitative study conducted among children in Mexico City, where a Mexican culinary rule of accompanying savoury food with sweet beverages was also identified (Theodore et al., 2011). Cultural norms play an important role in individual food choices, shaping personal eating patterns and food preferences, as well as defining what foods are eaten, when food is eaten and how it is prepared (Larson and Story, 2009). By considering that accompanying food with SSBs is a cultural behaviour in Mexico, we could assume that it is learnt early in life through an enculturation process (when culture is transmitted from one generation to the next), so that the behaviour is deeply rooted (Larson and Story, 2009). This could represent an obstacle when trying to reduce SSB intake in Mexican households as cultural beliefs and traditions might be difficult to change. It might also be the case that accompanying meals with SSBs is influenced by the marketing and globalization of the western diet, where accompanying certain foods (e.g. fast foods) with SSBs is presented as common practice (Larson and Story, 2009; Reisch et al., 2013). Future interventions need to consider these factors in their design and identify ways to modify cultural norms and practices in order to reduce intake of SSBs in adolescents.

The findings also suggest that water was not commonly used to accompany meals in this sample of adolescents. Participants often referred to the ease of purchasing SSBs compared to preparing beverages themselves or drinking water at lunchtime. Although serving a glass of water requires less effort than going out to purchase SSBs, this was not a common practice within the adolescents' home environment and further highlights the need to identify feasible and acceptable ways to promote water intake, particularly as an accompaniment to meals, as the beverage option of choice.

Although findings from Chapter 4 indicated that parental modelling was negatively associated with intake, the findings from this study showed that parents and other family members appeared to influence adolescents' intake of SSBs. Parental influence to drink SSBs could be explained by parental modelling and a lack of home rules regarding SSB intake at home. This is consistent with previous studies in European adolescents, where parental modelling (Bere et al., 2008; Grimm et al., 2004; Tak et al., 2011; van der Horst et al., 2007; Van Lippevelde et al., 2013) and permissive parenting practices in relation to food intake were associated with higher SSB intake (van der Horst et al., 2007; Verzeletti et al., 2010). Interestingly, these findings also suggest that siblings, grandparents and aunts/uncles can serve as role models and contribute to SSB availability at home, which adds to the limited evidence on the role of other family members in adolescent SSB intake. Thus, our research provides important insights into how wider family members' SSB intake patterns can influence adolescents' SSB intake, by shaping the range of drinks available at home and making SSB drinking a common practice, integral to the family's identity. Therefore, the adolescents' capacity for reflecting on what they drink at home seems to be either neutralized or attenuated by their families' intake practices. Future research should consider the role of parents and other family members in the intake of SSBs in Mexican youth by gathering more objective information from parents, or other close family members, in order to explore this association in depth. These findings could then be used to inform future behaviour change efforts.

The findings regarding the exploration of potential environmental cues that might promote habitual intake of SSBs suggest that availability seemed to trigger SSB intake. The availability of SSBs appeared to be consistent at home (i.e. always or almost always available) over the years, which prompted the behaviour and its repetition, eventually causing the automaticity of consuming SSBs, a characteristic of habitual behaviours. This is consistent with the findings of Tak et al. (2011), who also suggested that the availability and accessibility of SSBs at home may induce habit strength and habitual behavioural responses. The present study suggests that home eating occasions, together with the perceived importance of accompanying food with SSBs, also prompted repetition of the behaviour, making it a less cognitive decision and therefore more difficult for adolescents to have control over. This needs to be considered in future interventions, since modifying availability patterns could attenuate the context-behaviour association and therefore reduce the intake of SSBs among adolescents.

6.3.1 Strength and limitations

The current study provides in-depth information about how different home environmental factors shape and trigger the intake of SSBs in a sample of adolescents living in North West Mexico. To my knowledge, this is the first qualitative study to explore factors related to adolescents' SSB intake in the Mexican home context. However, the study is limited in terms of generalisability, as the interviews were conducted in a single city in North West Mexico. Also, the sample was homogenous sample in terms of socio-economic status, as participants were mostly from middle and high socio-economic backgrounds. Therefore, we cannot know if the participant discourse would be different among low-income adolescents. Moreover, recruitment of adolescent who were between 18 and 19 year was low (no longer regarded as minors under the national law) and those who took part were all living in their parental home. Hence, is not possible to know the experiences around the intake of SSB and perception of those adolescents who have moved out of the family home between 18 and 19 years old (which represents 12% of the population between 18-20 years old in Mexico) (Echarri Cánovas and Pérez, 2007)

In Study 2 (Chapter 4), dietary intake data was collected as daily intake of SSBs, and SSB intake was not differentiated based on different eating occasions or location (i.e. when adolescents were at home, at school, or other out-of-home activities), thus in addition to total daily intake, future studies should assess SSB intake separately in these contexts, as this will help the development of targeted interventions to reduce SSB intake in this sample of adolescents. Finally, on average, the least consumed drink by this group of adolescents was soda and the most consumed were sweetened fruit juices and aguas frescas. In previous analyses presented in Chapters 3 and 4 on average the most consumed beverage is soda. Thus, this may indicate that the adolescents who decided to participate in the interviews may in some way be more aware of what they consume and therefore try to consume drinks that they consider healthier, such as fruit containing drinks. From there may come the belief that fruit containing beverage are healthier than sodas. Although this can be in some way associated with the socio-economic level of the participants, more research is needed to investigate if this belief expands outside this sample.

6.3.2 Conclusion

In conclusion, findings in this sample of Mexican adolescent's support that the home environment, including availability, perceived importance and family influences, contributes to adolescents' SSB intake. Results also highlighted the significance that habitual behaviours and cultural and family norms play in the intake of SSBs in Mexican youth. These factors need to be considered when designing interventions that intend to modify SSB intake among Mexican adolescents and their families. Such schemes could complement the national SSB taxation policy currently in force, by directly addressing availability and facilitators of SSB intake at home, family influences and parental regulation.

6.4 Thesis implications

The findings from this study present a more detailed picture of the intake of SSB at adolescents' homes, however it only covers one part of adolescents' intake of SSBs. Although the home represents an important environment for food intake it also important to explore the SSB intake when adolescents are out-of-home. The next chapter provides an exploration of SSB intake while adolescents are in school and during other out-of-home activities. Additionally, based on the results from this study no indication that price or recent changes of prices have had an impact on purchase of SSB in household. Thus, further exploration of the perception on current taxation is presented in Chapter 8.

Chapter 7 Study 4: The role of the out-of-home environment in the intake of sugar-sweetened beverages in northern Mexican adolescents

7.1 Chapter overview

The findings from Chapter 4 provide some evidence that the school environment has the potential of predicting adolescents' intake of SSBs through the availability of SSBs in vending machines. It was also suggested that school availability was an important factor for those adolescents with a higher intake of SSBs. However, the online survey only assessed the availability of SSB in school without taking into account any other potential factors in the school environment that could promote the intake of SSBs.

As discussed in Chapter 2, evidence has also consistently shown that the food environment surrounding adolescents homes and school (i.e. corner shops, street vendors) is associated with the intake of SSBs (Ennis et al., 2014; He et al., 2012; Hearst et al., 2012; Laska et al., 2010). Although no studies to date have yet explored how the out-of-home environment affects the SSB intake among Mexican adolescents', there is some evidence pointing to the "toxic" food environment around primary schools (Barquera et al., 2018; Shamah-Levy et al., 2011), and its association with higher BMI (Hernandez-Barrera et al., 2016) (see section 2.3.3.2). This issue is important as adolescents have more independence than children to access different food outlets beyond the school environment within cities and towns.

Adolescence is considered the transitional period from childhood to adulthood between the ages of 12 to 19 years (Lenz, 2001). This transitional period, particularly late adolescence (17 to 19 years) (Zarrett and Eccles, 2006), is characterised by an increase in independence from parents (Melbye et al., 2016) and the progression from basic education (high school) to higher education (university) or employment (Lenz, 2001; Zarrett and Eccles, 2006). It is also known to be the most influential stage in the shaping and formation of their personal identities, values and beliefs (Lake and Townshend, 2006; Tyrrell et al., 2017). In gaining more independence from parents, adolescents tend to spend more time with friends (Wouters et al., 2010), which has been associated with unhealthy diets (Neumark-Sztainer et al., 1999) and an increased intake of SSBs through peer modelling (Bere et al., 2008; van der Horst et al., 2008) and social norms (Bruening et al., 2014; Lally et al., 2011a; Perkins et al., 2010; Wouters et al., 2010). Further exploration of the effects of the out-of-home environment might be useful to ascertain more precisely the social and environmental factors that are promoting the intake of SSBs among Mexican adolescents.

7.1.1 Aims and Research Questions

Overall, current evidence has shown that adolescents' intake of SSBs could be predicted taking into account out-of-home environment factors, including the schools and food environments near home and school. However, in Mexico limited evidence is available that inform about how the different contexts outside the home are promoting the intake of SSBs among adolescents. Therefore, one of the objectives of this study is to explore, via participants' perceptions, the different aspects of school and other out-of-home activities in relation to their intake of SSBs. Furthermore, considering the link between habit and SSB intake identified in Study 2 (Chapter 4) and the lack of the evaluation context-behaviour association through the online survey (see section 4.4.1), the second aim of this study is to identify potential environmental cues in the out-of-home environment that might trigger habitual SSB intake through analysing participants' statements. This study will answer research question 5 of this thesis:

RQ 5: What are adolescents' perceptions on how the out-of-home environment might play a role in their intake of SSBs?

> **RQ 5.1:** What are adolescents' perceptions about drinking SSBs in their schools and in other out-of-home activities?
>
> **RQ 5.2:** What are the potential contextual cues in the out-of-home environment that trigger SSB intake among a sample of Mexican adolescents?

The methods used to answer these research questions are described in detail in Chapter 5.

7.2 Results

Detailed sample characteristics are presented in Table 6.1 (Chapter 6). It is important to mention that most of the participants (75%) were attending high school and only seven participants were attending university. Also, most of the participants (62%) attended private schools. A total of nine themes resulted from the data analysis and are shown in Table 7.1.

Table 7.1 Resulting themes and sub-themes that explored SSB intake in the out-of-home environment

Themes	Subthemes	Nature of the codes
	School environment	
SSB intake at school	Reasons for not buying/drinking SSBs Differences between home & school	emergent from the data
Water at school	Water access/availability Acceptability of water fountains	emergent from the data
Facilitators of SSB intake in school	SSB availability	pre-determined
	SSB from home /outside Context around schools	emergent from the data
Adherence to nutrition policies in schools	Compliance with policy No to soda, yes to juices Perceived effectiveness of school policy	emergent from the data
Role of peers at school	Peer influence	pre-determined
	Peer preference	emergent from the data
	Other out-of-home activities	
Environmental facilitators of SSB intake during out-of-home activities (other than school)	Wide access/proximity Wide availability Marketing	emergent from the data
Personal facilitators of SSB intake during out-of-home activities (other than school)	Food intake Weather Taste Craving for something sweet	emergent from the data
Role of peers and family in SSB intake during out-of-home activities (other than school)	Family Friends	emergent from the data
	Potential environmental cues that promote intake of SSBs	
Environmental cues that promote SSB intake as a habitual behaviour	Cue of-eating out Cue-of cinema visit Cue-of visiting minimarket Cue-of social activities	emergent from the data

Themes for the school environment and other out-of-home activities are describe below.

7.2.1 School environment

7.2.1.1 SSB intake at school

Participants largely stated that they drank SSBs while they were at school. However, the respective frequency of intake varied across participants, with some reporting that they consumed SSBs every day, while others only occasionally.

> *"Well, sometimes I buy a coke, one can, and other times, they [school staff] sell horchata [sweetened rice beverage] or lemonade, then I buy these beverages."* (P17/Female/15 yrs./ HS/Public)

> *"It's like, I'm at school and during the breaks someone says: 'let's go and have a soda' and we go and buy soda. We drink it and that's it. Sometimes I crave horchata [sweetened rice beverage] so I go and buy one. But it is more often soda than horchata [sweetened rice beverage]."* (P14/Female/15 yrs./HS/Public)

A few participants mentioned that they don't buy or drink SSBs while they are at school, as they did not like what the school sells:

> *"Here at school are the tienditas [little shops] but I don't like anything … I don't like the juices, they taste really bad"* (P20/Male/16 yrs./HS/Private).

However, several adolescents mentioned buying SSBs from street vendors, minimarkets or corner shops, that are located a few metres from the school, after school hours or during the breaks (if permitted by the school authorities).

> "*During the break, we go to the mini-market to buy Nestea [iced tea] or Powerade [sport drink] because they are cheaper there [at the mini-market]." (*P16/Female/16 yrs./HS/Private)

Participants largely perceived that their SSB intake at school differed from their intake at home due to differences in the availability of SSBs in the two environments. For instance, adolescents who had a higher availability of SSBs at home seemed to not buy or drink SSBs at school and vice versa.

> *"Mainly because of availability, because I don't have all beverages like I do at home I have to drink water at school because it's what they provide."*
> (P12/Female/18 yrs./U/Public)

> *"Because those drinks [SSBs] are not available at home and the ones I like are available at school."*
> (P11/Female/19 yrs. /U/Private)

7.2.1.2 Water intake at school

Apart from talking about their intake of SSBs, many participants also expressed their preferences towards drinking water at school:

> *"I have the habit of always bringing one cold bottle of water with me, I freeze it every night. Here at school there are tienditas [little shops] but I don't like anything from there."*
> (P20/Male/17 yrs./HS/Private)

> "*Mm just water, I don't drink anything else.... yes, there is a tiendita [little shop], but I generally don't buy drinks there"*
> (P23/Male/16yrs/HS/Public)

Water consumption seemed to be independent from the intake of other beverages, including SSBs, as many participants expressed drinking both during school hours. Water was available in almost all schools by three means that varied across schools: i) water fountains; ii) bottled water; and iii) filtered water dispensers. Most schools had water fountains (tap water) within the premises. However, acceptability was good only among a few participants who said that they had no problem with tap water, while most participants explained that they did not like its taste, which prevented the use of water fountains in schools:

"For me, the truth is water fountains disgust me."
(P22/Male/17 yrs./HS/Public)

"Well, there are only water fountains and yuck no! It tastes like tap water and that taste bothers me"
(P5/Female/17 yrs. /HS/Private)

In some cases, the only way to access drinking water was through purchasing bottled water at the school's cafeterias or shops:

"Mm no, I have to buy water in the cooperativa [little shop] ... so I don't drink [water], for example sometimes I'm thirsty and I know I can bring water from home but I'm too lazy."
(P17/Female/15 yrs./HS/Public)

"You have to buy, there is no water fountain or 5-gallon water bottles" (P9/Male/17 yrs./HS/Public)

7.2.1.3 Facilitators of SSB intake at school

Apart from the limited access to water in some schools, intake of SSBs seemed to be facilitated by two main factors. The first was school availability, where almost all participants reported that a variety of SSBs was available for them to purchase on the school premises. There were three ways to purchase SSBs: in "cooperativas" or "tienditas" (small shops within the school where designated school staff sell snacks and beverages), cafeterias, which are bigger establishments and where hot food (and a larger variety of beverages) is served, and less commonly, through vending machines:

"They sell everything, soda, water, they sell iced teas like Nestea or Fuzetea [Iced tea brand name], mmm what else do they sell? ...I think they also sell processed juices like Jumex and del Valle [sweetened juice brand names]."
(P10/Female/18 yrs./U/Public)

> *"Yes, there is a shop, but they don't sell juices, they sell sodas of different flavours and iced teas as well."*
> (P18/Male/17 yrs./HS/Private)

Second, bringing SSBs to school from home or from outside seemed to be a common practice among adolescents and therefore was considered as a facilitator of SSB intake at school:

> *"Yes, for example, if there is some Jamaica [hibiscus water] left over from the previous day, I put it in my bottle... If not, I took a pink lemonade mix or just water…sometimes I bring lemonade or horchata [sweetened rice beverages] frescas and that's it."* (P2/Female/15 yrs./HS/Private)

> *"I don't buy anything at school. I bring 250 ml juice, only one little carton, it's the only thing I drink, I don't drink water."*
> (P22/Male/17 yrs. /HS/Private)

Adolescents mentioned that they had access to conveniences stores, pharmacies, street vendors or coffee shops in the vicinity to their schools (opposite to the school, a couple of blocks away etc.), facilitating their purchasing of SSBs during and after school hours:

> *"Just in front of the school there is a tent that sells lemonade. They sell fruits salads and aguas frescas like lemonade, and I think they also sell Jamaica [hibiscus water]."*
> (P27/Female/16 yrs./HS/Private)

> *"There is the drugstore, a coffee shop and the mini-market near my school."* (P1/Male/15yrs./HS/Public)

Reported reasons for purchasing food outside school were the price and the availability of more beverage options:

> *"There is a mini-market, it is cheaper than the school's shop, it has good prices and variety."* (P5/Female/17 yrs./HS/Private)

7.2.1.4 Adherence of Nutrition policies in schools

As discussed in Chapter 2 (Section 2.4.1), in 2014, the Mexican government restricted the sale of SSBs in all public and private education institutions, allowing the sale of selected SSBs in reduced portion sizes only on Fridays (see Table 2.5) (Secretaria de Gobernacion, 2014). During the interviews, participants who were attending high schools were the ones who mentioned the current nutrition policies. Despite this being an ongoing policy, adolescents largely talked in retrospect about nutrition policies in their secondary schools and how sodas were banned but industrialised juices were permitted. This, however, did not seem to apply to their current high schools, as participants stated that they continued buying a variety of SSBs at school:

> *"Well in secondary school, I didn't consume much soda because they only sell it to the teachers and they do not allow us [students] to buy soda … now in high school, I drink it often because they allow us to drink soda"*
> (P14/Female/15 yrs./HS/Public)

> *"In my secondary school, they didn't sell any of those [sodas], they always sold aguas frescas. In high school however they sell everything."* (P25/Female/17 yrs./HS/Private)

Despite schools' lack of adherence to these nutrition policies in high schools being noticed by adolescents, one participant emphasised the potential of food policies in schools by explaining how this restriction made him drink more water:

> *"I used to drink soda before, but since nutrition policies started they cancelled the sales. Now the only thing we can buy is juice, but because I don't drink that much juice it forces me to drink water"* (P19/Male/19 yrs./HS/Private)

7.2.1.5 Role of peers in the intake of SSBs at school

Many participants mentioned that their peers or close friends like to drink or purchase SSBs while at school:

> *"My best friend drinks Fuztea [iced tea brand] … and my peers always drink Coca-Cola and Sprite. But some days, the majority decide together what they are going to drink, and they buy Jumex [sweetened juice brand name]"* (P25/Female/17 yrs./HS/Private)

When they saw their peers drinking SSBs, many participants mentioned that they either asked for a sip, went to buy SSBs themselves or waited until they finished school to drink SSBs. They mentioned that they craved SSBs when they saw other people drinking, which influenced their beverage choices:

> *"When I'm with my friends they always buy sodas. In fact, it's because of them that I sometimes I drink soda."* (P1/Male/15 yrs./HS/Public)

> *"Well, if I see that they buy a Coke or something similar, I crave it then I go and buy one for me."* (P17/Female/15 yrs./HS/Public)

Conversely however, a few did not think that their peers' beverage choices influenced their own SSB intake during school hours:

> *"No never! If someone drinks horchata [sweetened rice beverage] I'm like 'why does everyone has to drink that?'. I was the only one who always had something different, "* (P16/Female/16 yrs./HS/Public)

> *"No, they don't influence me, not at all"* (P7/Female/19 yrs./U/Public)

Significantly, meeting the social expectations (social norms) seemed to be another factor when adolescents decided what to drink or not to drink at school. One female participant explained that she was more conscious of her beverage intake at school because she felt that people at school were judging her beverages choices, causing her to drink more water in that environment.

> *"At school, well no, at home no one judges me, and I can drink whatever I want, but at school everyone is nosy."*
> (P5/Female/17 yrs./HS/Private)

7.2.2 *Other out-of-home activities*

During adolescence individuals gain more autonomy and independence from their parents and generally they spend more time outside their homes (Christie and Viner, 2005; Spear and Kulbok, 2004). Bearing this in mind, it was important to explore the different contexts where adolescents might drink SSBs, apart from at home and at school, and how these might influence adolescents' SSB intake. All participants reported drinking a variety of SSBs when they were outside home and school.

7.2.2.1 Environmental facilitators of SSB intake during out-of-home activities (other than school)

The food environment facilitated the intake of SSBs by three means. Firstly, wide access to shops was constantly mentioned across all interviews. Participants referred to the ease of finding a place to buy SSBs, particularly one national mini-market chain called Oxxo, which was repeatedly mentioned by participants as a preferred place to purchase SSBs:

> *"In an Oxxo more than anywhere else, [they] are just around the corner everywhere."* (P22/Male/17 yrs./HS/Private)

> *"There is always an Oxxo"* (P7/Female/19 yrs./U/Public)

Most participants purchased their beverages in places close to their homes, indicating that the vicinity between the home and shops was important for them and thereby facilitated SSB intake in this sample:

> *"Well, whatever is closer to me, an Oxxo or closer to my house there is a [name of local supermarket] where I go, it's just behind my house"* (P27/Female/16 yrs./HS/Private)

> *"In markets, in Oxxo or Wal-Mart, depends on what's closest"* (P4/Male/16 yrs./HS/Private)

Secondly, the wide availability and range of SSB choices in shops seemed to also facilitate intake and allowed adolescents to expand their drinking choices. One female participant explained that she came to know different beverages by going to the mini-market:

> *"I found out about these beverages [SSBs] because I saw them in the shops"* (P25/Female/17 yrs./HS/Private)

A third facilitator of SSB intake seemed to be the ubiquitous presence of localised marketing of SSBs. Although this was not mentioned by many, one male participant explained how soda brands were advertised in many restaurants and eateries and how this was something they were exposed to all the time:

> *"Anywhere you go you'll find publicity from them [industry], in every taco shop you'll find the tables from Coca-Cola and in every event you'll also see tables from Pepsi and also from Coca-Cola."* (P19/Male/19 yrs./HS/Private)

7.2.2.2 Personal facilitators of SSB intake during out-of-home activities (other than school)

On a more individualised level, three main factors facilitated the intake of SSBs outside the school and home. Firstly, food intake was the most mentioned personal facilitator of SSB intake when out-of-home. For example, some participants perceived that their beverage choices depended on the type of food they were having (i.e. spicy, salty etc), as the taste of specific meals was complemented by different beverages. When eating out, participants tended to choose SSBs to complement the food they consumed:

> *"I chose the beverage depending on the food. For example if I eat crisps then maybe with iced tea or a soda, if it is a pastry it's with horchata [sweetened rice drink] or something milky."*
> (P15/Female/19 yrs./U/Public)

> *"If I eat a hot dog I'll drink a Coke, if I eat chicken wings I'll drink sparkling lemonade. Simply because the mix of flavours are very good. When they tell us what we are going to eat we usually associate that drink with that food and then we buy it."*
> (P19/Male/18 yrs./HS/Private)

Secondly, adolescents largely perceived that they drank SSBs because they craved them after seeing them or by craving them first and then purchasing them.

> *"I see first, I see what I crave more and it's a juice, Arizona [iced tea brand], soda or something like that."*
> (P17/Female/15 yrs./HS/Public)

> *"It depends on what I see and which taste I crave"*
> (P23/Male/16 yrs./HS/Public)

Participants also highlighted that they drank SSBs when they craved something sweet, indicating a strong preference towards the sweetness of SSBs

> *"Sometimes it's like I'm not thirsty but I crave something sweet, that's when I buy a lemonade."*
> (P13/Male/19yrs/U/Private)

Thirdly, participants perceived that the weather (average temperatures of around 29 °C) contributed to the intake of SSBs when they were outside and felt they needed something refreshing that would help to quench their thirst. Very few participants referred to drinking water to satisfy their thirst while outside:

> *"When I'm very hot it's a Powerade [sport drink brand name] or [electrolyte drink brand name] or something like that."* (P19/Male/17 yrs./HS/Private)

> *"Normally, because of the heat the first thing I think of is soda."* (P27/ Female/16yrs/HS/Private)

7.2.2.3 Role of peers and family in SSB intake during out-of-home activities (other than school)

Participants reported that they were rarely on their own when they were outside, instead they were mostly with friends or family. A few mentioned that the intake of SSBs coincided with family activities, such as going to the cinema or going to a restaurant:

> *"In restaurants, if I go with my family it's sparkling lemonade"* (P21/Male/18 yrs./HS/Private)

> *"When I go to the cinema with my mom and my brother that's when we buy a lot of everything, soda and many other things"* (P27/Female/16 yrs./HS/Private)

On the other hand, common activities undertaken by participants with their friends that promoted the intake of SSBs were eating out, going to the cinema, walking and/or driving around the city. These activities were sometimes attached to certain social expectations and in some cases, promoted the consumption of SSBs as a means of inclusion, because SSBs were what everyone else decided to drink:

> *"We all drink the same"* (P3/Male/16 yrs./HS/Public)

> *"It's what we all choose, we vote"* (P5/Female/17 yrs./HS/Private)

Similar to the school context, participants explained how 'hanging out' with their friends influenced their beverage intake during out-of-home activities.

> *"Well, lately when I go out with the two friends I told you about, sometimes we go and get lost, and what we do lately is go and buy, what's the name? [pause] ... [refreshment stall name] and we buy Jamaica [hibiscus water] or lemonade or sometimes we combine both"* (P1/Male/15 yrs./HS/Public)

> *"Because the others drink Coca-Cola and then I crave it"* (P17/Female/15 yrs./HS/Public)

7.2.3 *Potential environmental cues that promote intake of SSBs at the out-of-home environment*

Adolescents' beverage intake seemed to vary according to the environment. Therefore, one of the aims of this study was to identify, based on habit definition (section 2.2.3), the potential environmental cues that could be triggering SSB intake in out-of-home activities and at school (a stable context which adolescents encounter almost every day). The constant availability of SSBs in schools was mentioned by adolescents during the interviews, suggesting that SSB availability may be cueing the intake of SSBs and promoting repetition of the behaviour until it becomes automatic, and potentially a habit. Among other out-of-home activities, eating out in restaurants or other food outlets seemed to also cue the intake of SSBs:

> *"In a restaurant it's sparkling lemonade, always sparkling lemonade. Or sometimes it's soda, Coca-Cola, but most of the time it's lemonade."* (P15/Female/19 yrs./U/Public)

> *"I drink Coke when I go to restaurants, in my house there is none, they [parents] buy diet Coke and I don't like it, that's why I go and buy it in a vending machine or when I go to a restaurant."* (P6/Male/16 yrs./HS/Private)

Activities such as visiting mini-markets and going to the cinema, also appeared to trigger SSB intake. For instance, going to the cinema was linked to drinking SSBs for most participants. Also, social activities like parties and sporting events were accompanied with the intake of SSBs.

> *"Iced tea when we go to watch a match [sport] or when we buy crisps we also buy iced tea or soda, but mostly we buy iced tea or Gatorade [sport drink brand name]."*
> (P5/Female/17 yrs./HS/Private)

7.3 Discussion

This study qualitatively explored the perceptions of a sample of adolescents living in an urban area in North West Mexico with regards to the intake of SSBs when outside the home environment (including school and other out-of-home activities). The findings revealed nine themes related to SSB intake in these contexts, which should be considered when developing or updating initiatives to reduce the SSB intake of this population.

The availability of SSBs on the school premises was a factor perceived to contribute to the intake of SSBs while adolescents were at school. This finding is consistent with results from Chapter 4 and from previous literature that has reported a positive association between the availability of SSBs and intake at school (Grimm et al., 2004; Hebden et al., 2013; van der Horst et al., 2008). This suggests that school nutrition policies could potentially moderate SSBs' availability and adolescents' intakes of SSBs by restricting their sales. However, inconsistencies were identified, as the current policy that restricts SSB sales in Mexican high schools was not being fully implemented as, according to participants, a variety of SSBs were available at school during school hours. Evaluating the schools' adherence to this policy was outside the scope of the current study. However, future studies should investigate the level of policy implementation in schools and explore the potential barriers faced by schools in adhering to these nutrition policies. Despite the restriction in the sales of SSBs at school, it is not clear how school policies could also restrict students from bringing SSBs from home and shops on their way to school. This is an important consideration and shows how other environments (home and food environments) can interact with each other, by potentially limiting the effectiveness of any school-based policies with regards to reducing SSB intake in schools.

Most adolescents reported that water (either bottled or tap) was available to them on school premises, however some participants had to buy it from their school cooperatives, which hindered water intake and possibly facilitated the consumption of other beverages available at school. Free drinking water was still not available in all schools, and even when it was, concerns about water taste were mentioned by some adolescents. There is scarce evidence about the techniques used in water treatments, however it is likely that these processes and the quality of the pipes contribute to the perceived bad taste of tap water adolescents referred to during the interviews (González-Villarreal, 2016). This concern, together with water safety issues, have resulted in the public's avoidance of tap water and the spike in the purchase of bottled water (Pacheco-Vega, 2015) and other beverages, including SSBs. In recent years, access and promotion of water intake in schools has been an objective of academic and government bodies in Mexico (Carriedo et al., 2013). For instance, there has been a national strategy to install water fountains in schools (Diario Oficial de la Federacion, 2015). Although this could be a positive step towards substituting SSB intake with water, it is unclear if the issue of water taste reported by this sample of adolescents will be addressed through this initiative. As such, behavioural strategies that promote positive messages in relation to water consumption would be needed to complement any policy changes including the provision of potable water in schools.

Participants perceived that peer influences, peer modelling and the social expectations attached to different activities with their peers (social norms) in the out-of-home environment, all affected their beverage choices. This is in line with previous cross-sectional studies that showed an association between perceived peer modelling, social norms and SSB intake (Bere et al., 2008; Grimm et al., 2004; Perkins et al., 2010; van der Horst et al., 2007). This suggests that future interventions aimed at reducing SSB intake in Mexican adolescents should attempt to modify the social norms that are attached to the intake of SSBs. However, diverse kinds of activities, each one with its specific social norms, might play a crucial role in the relationship between peer influences and SSB consumption. Consistent with our findings, Larson et al. (2009). highlighted the role of social norms and attitudes among a group of peers and how this has an impact on the food that adolescents choose to consume Therefore, in order to reduce the intake of SSBs, it is important to take into account the social norms in different contexts of adolescents' lives and to consider feasible ways to modify social norms in order to facilitate a healthy diet.

Previous studies have suggested that some characteristics of the neighbourhood food environment, such as the density and proximity of food outlets, contribute to adolescents' consumption and purchase of SSBs (Hearst et al., 2012; Laska et al., 2010). Some of the results from the present study are consistent with this notion. For example, the easy access, the availability of SSBs, the proximity to shops and marketing were all perceived components of the food environment that contribute to SSB intake. The distance to food outlets was considered an important factor affecting adolescents' SSB intake, thus changes to food access near schools are required, including the potential need for food policies to be extended to food sellers outside the school. Moreover, the wide variety of SSBs sold within the shops also seemed to be influencing adolescents' decision-making towards SSBs. As suggested by Caspi et al. (2012), future research in Mexico should focus on auditing the products available in corner shops or minimarkets to assess objectively how these beverages are being offered and therefore propose appropriate changes to improve adolescents' food environment towards healthier diets. Although taxation of SSBs has the potential to direct consumers towards healthier options, it needs to be complemented with other strategies such as food labelling, changes in food display in food outlets and the reduction of portion sizes (Hollands et al., 2017, 2013).

Based on the findings, eating out (outside the home and school) and specific activities, like going to the cinema, appeared to trigger the intake of SSBs in this sample of adolescents. This strongly suggests the context cue the repetition of the behaviour until it becomes automatic. To the best of my knowledge, no study to date has examined the out-of-home contexts that automatically trigger SSB intake in adolescents. More research is therefore needed to understand the frequency with which adolescents are exposed to eating out, or the specific components of eating out (i.e. marketing or accompanying certain foods with SSBs) that may be triggering SSB intake every time the cue is encountered. Nonetheless, our findings provide an indication of what types of environment could be linked to habitual SSB intake.

7.3.1 Strengths and limitations

This study is the first to provide in-depth information about how different factors outside the home environment shape and trigger the intake of SSBs in a sample of Mexican adolescents and to examine the contexts that might automatically trigger SSB intake in adolescents. Therefore, findings provide important insights on how the environment and social activities might play a role in adolescents' habitual intake of SSBs. The study, however, is limited as data is from a single city in North West Mexico and as such, the ability to generalise to other settings is restricted. Moreover, this was a homogenous sample in terms of socio-economic status as participants were mostly from a medium and high socio-economic background with a higher number of participants attending private schools than public schools. Recruitment of university students was low which prevented full comparison between participants' statements in relation to the school environments (high school vs. universities). Moreover, this study did not capture the perception of adolescent who are not in education, which according to the latest census account for 56% of young people living in Mexico between the ages of 15 and 24 years old (Instituto Nacional de Estadisticas y Geografia, 2016). Finally, as mentioned in section 4.4.5, weather seasonality could influence adolescent's intake of SSBs. However, because the interviews were all conducted during springtime it was not possible to capture any variation in the adolescents' perceptions in regard to their intake of SSBs due to seasonality. Nonetheless, some adolescents mentioned, independently of the current season, how the hot weather prompt their consumption of SSBs (see section 7.2.2.2).

7.3.2 Conclusion

The current study provides new evidence on the factors contributing to SSB intake in a sample of Mexican adolescents when outside the home environment encompassing the availability and accessibility of SSBs, as well as peer influences. Findings from the present study suggest that each environment in which adolescents develop might influence the intake of SSBs. Also, one environment could influence SSB intake in another environment, for instance, the availability of SSBs at home or in food outlets may contribute to the intake of SSBs at school. This supports the notion that socio-ecological approaches are needed in order to promote healthier beverage intake among Mexican adolescents. For example, school policies have the potential to reduce the intake of SSBs while adolescents are at school, but periodical evaluation and support to schools are needed to ensure policy implementation. In addition, availability as well as promotion of free water drinking within schools could help to tackle the high intake of SSBs. As the food environment surrounding adolescents appeared to direct them towards the intake of SSBs by providing easy access and an ever-wider variety of SSBs for purchase, interventions that aim to modify micro-environments (restaurants, shops, supermarkets) could also help to reduce the intake of SSBs in Mexican youth. The role of peers appeared to be another factor influencing SSB intake among adolescents, thus social relationships in this life stage are important to consider when targeting adolescents. Finally, further research is needed to explore how habitual SSB intake is formed and how it operates among Mexican youth. As adolescents spend a considerable amount of their time away from home, these are important factors to consider for researchers and policy makers when designing interventions and policies to reduce SSB intake among Mexican adolescents.

7.4 Thesis implications

The findings from this study indicated a tangible link with the findings from Chapter 6, where the availability of SSB in the home environment facilitates adolescents' intake of SSB in schools. Moreover, this study highlighted the role of the food environment and how it prompts the purchase of SSBs. Notwithstanding questions remain as to whether the tax has duly affected adolescents' purchase of SSBs. This is explored in more detailed in the following chapter.

Chapter 8 Study 5: Exploring perceptions of the Mexican sugar-sweetened beverage tax among adolescents in North West Mexico

8.1 Chapter Overview

Based on finding from Study 3 and 4, there are indications that adolescents and their families tend to purchase SSBs regularly. As described in Chapter 2 (Section 2.4.2), a specific excise tax (a fixed dollar amount dependent on the quantity purchased, 1 peso (£0.04)/L) was implemented to non-alcoholic beverages with added sugars in 2014. Therefore, considering that data collection for this study was carried two years after the implementation of the tax it was important to explore how adolescent have perceived this increase in price and whether it has influenced their beverages choices.

Recent evidence suggest that the tax has been able to reduce purchases by 7.6% (Colchero et al., 2017b) and per capita SSB sales declined by 7.3% (Colchero et al., 2016). These findings suggest a potentially beneficial effect of the taxation. However, a number of gaps in the literature have been identified that warrant further investigation. First, the effect of the tax could be lower among high consumers of SSBs (Etilé and Sharma, 2015) and higher among groups with low socio-economic profiles (Colchero et al., 2017b). Second, a 10% increase in price might not be sufficient to promote reductions in SSB intake; therefore, there might be a need for a higher tax to reduce the prevalence of obesity (Basu et al., 2014; Briggs et al., 2013; Dharmasena and Capps, 2012; Manyema et al., 2016).[7]

[7] Part of section 8.1 to 8.3 were published in Public Health Nutrition: Ortega-Avila, Ana G, Papadaki, Angeliki, and Jago, Russell. Exploring perceptions of the Mexican sugar-sweetened beverage tax among adolescents in north-west Mexico: a qualitative study. Public Health Nutrition, 2017, 21:618–626

Third, if a higher tax were implemented, it is unclear what the SSB substitution patterns might be or whether people might shift to non-caloric beverages, cheaper SSBs or other unhealthy foods (Zhen et al., 2010). Furthermore, in settings with informal markets (such as Mexico) prices may vary depending on beverage brands or purchase locations (e.g. street vendors, convenience stores or supermarkets) and a 10% increase in SSB prices might not be uniform, thereby potentially affecting the impact of the tax (Colchero et al., 2015). Finally, the success of the tax might depend on how informed and aware consumers are about it (Leicester et al., 2012) .

8.1.1 Aims and Research questions

To date, the effectiveness of the SSB tax in Mexico has been evaluated from an economic perspective, by assessing changes in SSB purchases and sales (Colchero et al., 2017b, 2016). However, no study has examined the perceptions of consumers regarding implementation of the tax and its potential to reduce SSB intake. Therefore, the first aim of the present study was to qualitatively explore how aware adolescent were on current taxation. The second aim was to assess adolescents' perceptions on SSB tax and to assess their experiences of how taxation has affected their purchases and intake of SSBs. Finally, to explore substitution of SSBs. This study will answer research question 6 of this thesis:

RQ 6: What are adolescent's perceptions and awareness of current SSB tax?

> **RQ 6.1:** How taxations have affected adolescents' purchase and intake of SSB?
>
> **RQ 6.**2: What are adolescents' perceptions on the substitution of SSBs with other beverages?

The methods used to answer these research questions are describe in detail in Chapter 5.

8.2 Results

Detailed sample characteristics are presented in Table 6.1 (Chapter 6). Four main themes were identified that helped to answer the research question previously established. The resulting themes and subthemes are presented in Table 8.1.

Table 8.1 Resulting themes and subthemes that explore perception and awareness of taxation

Themes	Subthemes
1) Awareness or lack of awareness of taxation	Inflation awareness Aware vs. not aware
2) Perceptions on effectiveness of tax	Effective vs. no effective Tax indifference Tax insensitive Effective for Low-income
3) Reason why the tax is not effective	'Addiction' to SSBs Higher tax needed/price Taste Purchase whim/need over price Afford despite the tax
4) Substitution behaviours	

8.2.1 Awareness of taxation

Participants were mostly unaware of the SSB taxation ("*I didn't know why the price went up", P4/Female/17 yrs.)*, and some reported not having noticed a price increase ("*I didn't know anything… honestly I haven't noticed" P2/Female/15yrs.)*.

If participants were not aware of the taxation, the researcher briefly explained the tax policy. Two participants then realized that they had heard about the price increases. Those participants who stated that they were aware of the taxation of SSBs in Mexico, mostly via mass media, such as TV and the news

> *"I have only heard about this on the news, that the prices increased due to health issues, but apart from that I haven't heard more."* (P23/Male/16 yrs.)

Among participants who knew about the tax, a few were aware of its aim to some extent, as two participants stated:

> *"Oh yes I heard, something like let's charge them more so that they (people) don't buy (SSBs) because we are very fat."* (P21/Male/18 yrs.)

> *"Yes, something about (SSBs) are more expensive now. It is because children in Mexico are fat"* (P16/Female/16 yrs.)

Similarly, some participants explained that they knew something about the taxation; however, they acknowledged that they did not know the details, such as the amount of the price increased or when the tax was implemented.

> *"I don't know if the tax has already been implemented, but I knew that the Mexican government wanted to impose taxes on sugar, juice, sodas, tea, and I had heard that water too, they also wanted to add taxes to water"* (P24/Male/17 yrs.)

> *"...I don't really know much, I couldn't tell you 'this is the tax."* (P12/Female/18 yrs.)

A few participants were aware of the increased price of SSBs; however, they associated this with the beverages' yearly inflation rate instead of the SSB tax

> *"Well, I didn't know specifically about sugar, because in my opinion everything costs more than before."* (P20/Male/18 yrs.)

> *"Yes, I knew (about the tax), because I always used to go to buy the sodas and juices when I was younger… And there was a time when all the prices went up. We bought it anyway, we*

did not stop buying them, but I noticed the change in the price of the products…But no, the truth is I did not know why it had been (the price increase." (P6/Male/17 yrs.)

8.2.2 Perceptions of how the tax has affected SSB intake

Participants mostly perceived that the SSB tax would not affect their SSB consumption patterns, because their intake had not changed, and that the tax would not affect them

> *"I don't think it will work, habits are hard to change."* (P9/Male/17 yrs.)

> *"It is a nonsense that they wanted to reduce the intake by doing that (tax)… to me it doesn't sound possible to do; one peso per litre is not going to make me buy less."* (P16/Female/16 yrs.)

Participants largely perceived that the tax would not influence their decision to buy SSBs or modify their, or their families', SSB intake

> *"No (tax won't affect), I would still buy them...if I have the money I will buy them."* (P11/Female/19 yrs.)

> *"I don't think so [reduce intake], because while you keep liking it (SSBs) you are going to keep buying it no matter the price… it won't affect my family either."* (P25/Female/17 yrs.)

Some participants perceived that the taxation would not reduce SSB intake for other people, who would keep drinking the same beverages habitually

> *"... If people are used to drinking soda with every meal, they are not going to say: 'I'm going to stop drinking the beverage that I have been drinking all my life and the one my family have drunk just because they increased [the price] by 1 peso'"* (P10/Female/18 yrs.)

However, other participants expressed that, SSB tax would not affect them personally, however, they thought that other people, particularly those from low socio-economic backgrounds, could be affected by the price increase of SSBs.

> *"Probably it [tax] could affect low-income people. Especially because 10% could sound like a lot, even though it is only 1 peso or probably 50 cents."* (P24/Male/17yrs.)

> *"... Oh well, low-income people who like soda a lot. For example, I think if they raise the price they [low-income people] will stop buying it. Because it would be a luxury, so I don't think it will be: 'I don't have money and I'm going to buy that', no. I think they would drink more water or something cheaper."* (P28/Female/17 yrs.)

8.2.3 *Reasons why the SSB tax was not perceived as having affected SSB intake*

Three sub-themes emerged when participants were asked to reflect on whether or not the tax would affect their SSB intake, and their reasons for this. Perceiving that the implemented increase in price was low and insufficient to change SSB intake, taste preferences and addiction to SSBs were the main reported reasons why participants perceived the tax would not affect SSB intake at a personal level and for other people in Mexico.

8.2.3.1 Price

Participants largely perceived that the 10% price increase following implementation of the tax was too small not influence their SSB purchases

> *"Because it is only 10%, I do not take much into account."* (P1/Male/16 yrs.)

> *Well I say that it (price) didn't go up so much [laughter] and I'm still going to buy it. It doesn't affect me because it doesn't*

go up so much, it rises like a peso or 50 cents…
*(*P14/Female/15 yrs.)

According to several participants, the tax would only affect them if it were higher:

> *"If the price was much higher than it was before, I think yes, I would consider it, but the 10% increase is not that much."*
> (P12/Female/18 yrs.)

> *"Probably if a soda can, I don't know, I think if it costs 10 or 20 pesos more, I would be like: 'I better not, I'll better buy something else'."* (P13/Male/19 yrs.)

Participants who thought the tax should be higher, in order for it to affect SSB purchases, suggested that an average increase of 5–10 pesos/litre might cause them to reconsider:

> *"If it costs 10 pesos it needs to go up 5 more. Then it would be like: 'Already went up too much I'm not going to buy it."*
> (P28/Female/17 yrs.)

Some participants, however, perceived that an even higher price increase (between 15–20 and 40 pesos per litre) was necessary for them to consider changing:

> *"... they will have to increase 20 pesos per litre, in that way it is going to hurt."* (P21/Male/18 yrs.)

> *"We need a bigger blow… 15 to 25 pesos per litre, something like that."* (P22/Male/17 yrs.)

A lack of awareness of the price of beverages was reported as a reason for dismissing taxation, as one participant explained:

> *"It won't affect me [tax]) because, like me, other people don't remember the juice prices of last year."* (P10/Female/18 yrs.)

8.2.3.2 Taste preferences

It seemed that taste was an important driver of participants' SSB purchases, and some stated that when they liked the taste of a beverage, price was not an issue:

> *"The truth is that I do not buy it for the price, I buy it for the taste."* (P3/Male/16 yrs.)

> *"...because as long as I continue to like it [SSBs] I will continue buying at all costs."* (P25/Female/17 yrs.)

One participant further explained that sometimes he was willing to pay five times the retail price because of the taste and because consuming SSBs is part of the enjoyment of certain activities:

> *"...I recently went to a concert and the soda of 700 ml cost 60 pesos [£2.50] but I bought it, because it is soda and it is delicious, and I'm going to drink soda and it is refreshing."* (P6/Male/17 yrs.)

8.2.3.3 "Addiction" to SSBs

A few participants stated that the tax would not affect their SSB intake because of their perceived "addiction" to SSBs

> *"Because it's an addiction, I will buy it anyway."* (P14/Female/15 yrs.)

The term *"a*ddiction" was also used when some participants talked about why they thought the tax would not work for people in Mexico

> *"It's that it's like an addiction, it's like drugs, no matter the price they [other people] are going to buy (SSBs) because it is something that people consume and like."* (P19/Male/18 yrs.)

"Because most people are already addicted to a particular beverage. Because even if the government increases the price, it is likely that they [other people] will keep drinking" (P4/Female/17 yrs.)

8.2.4 Preferences for substitution of the taxed SSBs

Some participants reflected on what would happen to their SSB intake if prices increased more drastically. They mostly stated that if SSB prices increased further via a higher tax, they would consider substituting SSBs with other beverages, such as home-made drinks (e.g. 100% fruit juices and "*aguas frescas*"), non-caloric instant-flavoured drinks and water:

"In that case, I would buy a juice, or you know what I would go to the fruit shop and I would buy 2 mangos and I would prepare a mango water, it's cheaper." (P17/Female/15 yrs.)

"I think it will be like in the old times when people prepared more aguas frescas at their homes. Buying (SSBs) would be more like a luxury and it will be only for parties." (P8/Male/19 yrs.)

8.3 Discussion

This qualitative study of adolescents residing in North West Mexico demonstrated that participants were largely unaware of the SSB taxation. Overall, participants believed that the tax would not affect their SSB intake, apart from among people with a low income. The perceived insufficiency of the current price increase, taste preferences and perceived addiction to SSBs appeared to be the most important reasons why participants felt taxation would not lead to SSB reductions. If SSB prices were to increase further via a higher tax, substitution of SSBs would be towards home-made drinks, 100% fruit juices, non-caloric instant-flavoured drinks and water.

Taxation of SSBs in Mexico has been covered extensively by the national and international media (Colchero et al., 2016). The majority of adolescents in this sample, however, appeared to be unaware of the tax. This may indicate that information on the SSB tax has not specifically been targeted at adolescents. Research on behavioural economics suggests that the way taxes are framed or presented could affect their impact (Leicester et al., 2012). Thus, it may be that the current Mexican SSB tax has been framed in a way that makes it less salient to adolescents (e.g. size of the tax or the label attached to the tax), and, consequently, adolescents were mostly unaware or unaffected by it. Therefore, the development of a tax-framing strategy directed at adolescents could enhance the impact of the SSB tax on the younger populations in Mexico.

An underlying assumption about tax policies is that individuals are aware that the change in prices is due to taxes, so they are conscious of the tax as a penalty for consumption behaviour (Alm and Bourdeaux, 2014; Leicester et al., 2012). However, our findings suggest that most adolescents in our sample were not aware of the price increases being due to tax. Although purchasing behaviours, financial independence and the amount of financial resources participants had (and how much they spent on food) were not explored in this study, earlier literature has suggested that children normally have pocket money or an allowance, which they tend to spend on food and beverages (Borradaile et al., 2009; Cash et al., 2016; Cowburn et al., 2016; Dennisuk et al., 2011). Therefore, we could assume that adolescents in this sample were exposed to beverage prices, and thus SSB price increases; however, rationalisation, or the lack of it, may have played an important role in their decision-making, leading to insensitivity to price changes (Harbaugh et al., 2001). Thus, more research is needed to investigate whether the reported tax unawareness might stem from lack of price exposure, rationalisation during food purchasing or insensitivity to price changes for other reasons, in a representative sample of adolescents in Mexico.

Adolescents in this sample largely perceived that the SSB tax would not cause them to reduce their SSB intake. The literature suggests that perceived effectiveness is the strongest predictor of acceptability (Petrescu et al., 2016). Thus, the low levels of acceptance of the SSB taxation could cause increased resistance to perform the desired behaviour (i.e. reduce SSB intake) among consumers. Therefore, a future tax-framing strategy should also identify ways of promoting SSB tax acceptance among this sample of adolescents that would elicit rationalisation, helping them to approve the tax and reduce SSB intake (Bos et al., 2013).On the other hand, knowledge and understanding of factors that influence consumers' acceptance are crucial to enhancing the objective of taxation (Bos et al., 2013).

The findings highlighted three factors that could affect the impact of taxation among this sample of Mexican adolescents. First, participants largely thought that a 10% increase would not be sufficient for them to reduce their SSB intake. Most studies that have simulated the effect of the SSB tax suggest that a 20% increase in SSB prices would reduce caloric intake and the prevalence of obesity and being overweight in different countries (Basu et al., 2014; Briggs et al., 2013; Dharmasena and Capps, 2012; Manyema et al., 2016; Schwendicke and Stolpe, 2017). Therefore, the current tax rate (approximately 10%) could indeed be a drawback when aiming to reduce intake among adolescents from the middle and upper classes and among high consumers (Cahuana-Hurtado et al., 2013). Second, adolescents referred to taste preferences as a factor hindering the potential effects of taxation. This finding stresses the importance of taste preferences in the context of SSBs, and is in agreement with earlier findings in this thesis and in the broader literature that suggest that taste is a factor influencing adolescents' decisions to consume SSBs (Battram et al., 2015; Bere et al., 2008; Block et al., 2013). Third, some participants used the “term” addiction as another factor that could affect the taxation’s impact. This finding is consistent with results from a qualitative study exploring US adolescents’ views on SSB taxation, where “addiction” was also used by participants as a factor that could minimise the effect of the tax (Krukowski et al., 2016). Participants in this sample explicitly used the term “addiction” to explain why they did not change their SSB intake following the price increases, referring to SSBs as a habit, but without indicating that they would observe physiological or emotional discomfort at the idea of not drinking SSBs. Addiction has been described as “an extreme form of habit formation” (Zhen et al., 2010), and it is likely that adolescents have gone through a process of habit formation causing a dramatic increase in their SSB intake due to repetition of the behaviour and in response to environmental cues, such as home and school availability of SSBs (Lally et al., 2010; Tak et al., 2011). All these factors should be considered by policy-makers investigating ways to increase the effectiveness of the SSB tax in Mexico. Despite not having been discussed with participants in this sample, factors such as heavy marketing and publicity regulations (Barquera et al., 2018; Hernández-Chávez et al., 2017; Velasco et al., 2016), parental and peer modelling (Bere et al., 2008; Bogart et al., 2017), leisure activities (Mazzonetto and Fiates, 2014), the environment (i.e. proximity to shops, home availability) (Hernandez-Barrera et al., 2016; Veur et al., 2013) and scarcity of potable water in schools (Carriedo et al., 2013) and public spaces (Ortega-Castaneda and Vega, 2016) might influence beverage choices among young people, and could therefore also influence adolescents' perceptions and acceptance of SSB taxation. Further research into these factors is needed to provide a better sense of the taxation's contribution to SSB intake in Mexican adolescents.

When referring to tax effectiveness, it is also important to consider individual differences in levels of SSB intake, as how the SSB tax would affect SSB intake could vary across low, moderate and high SSB consumers. SSB intake in this sample of adolescents was over one litre per day, which is above the national mean (543 ml/day) (Stern et al., 2014) thus constituting our sample as high consumers. A recent study of Australian household data suggested that elasticity estimates (changes in the demanded quantity of a product following price changes) were lower for high, compared to moderate, consumers of SSBs, suggesting that high consumers are less likely to be affected by price changes (Etilé and Sharma, 2015). However, this does not imply that the tax would not affect high consumers, as this group consumes more SSBs in absolute terms than moderate consumers. Thus, the tax would have a greater impact upon the absolute consumption of high SSB consumers, potentially translating into body-mass reductions. However, the potential impact of this chain of effects on well-being remains unexplored. Similar studies need to be conducted in Mexico to investigate the effect of the tax across populations with different SSB intakes (i.e. high versus low), where links between intake and habit strength should be considered as mediating factors of any elasticity changes.

8.3.1 *Strengths and Limitations*

The main strength of this study is the provision of in-depth information on adolescents' perceptions of the Mexican SSB taxation, in a sample with a high SSB intake. Interviews were conducted two years after implementation of the tax, which permitted exploration of whether the tax had influenced SSB intakes among this sample. The sample had a similar number of females and males. However, it was relatively small, the response rate (9.5%) was low and data was collected from a single city in North West Mexico – factors that hinder the external validity of the study. Another limitation was that most participants came from a medium/high socio-economic background, preventing the generalisation of findings to low-income adolescents. Nevertheless, thematic data saturation was reached for this sample of adolescents, suggesting the potential applicability of the findings to Mexican adolescents of similar characteristics.

8.3.2 *Conclusions*

The current findings provide important insights into the views of this sample of Mexican adolescents regarding the SSB tax, by pointing out several possible limitations of the tax policy in Mexico, as well as several perceived reasons why the tax would not lead to reductions in SSB intake. These factors should be considered by policy-makers during any future tax reforms to improve the effectiveness of the SSB tax. Our findings could also inform the development of interventions targeted at Mexican adolescents that would complement the current SSB taxation.

Chapter 9 Overall discussion

9.1 Overview

This chapter summarises the main findings of the thesis and discusses their implications for theory, interventions, research and public health policies. Beyond this, the strengths and limitations of the thesis are examined, and overall conclusions are proffered.

9.2 Summary of main findings

The high intake of SSBs is among the principal factors promoting weight gain and the increased risk of NCDs (Ambrosini et al., 2013; Luger et al., 2017; Malik et al., 2013). Strategies to reduce the intake of SSBs have been approached mainly from policy overlooking the individual, social, and environmental factors that also promote the intake of SSBs. This is of particular importance in Mexico, where SSB intake is among the highest worldwide (Singh et al., 2015).Thus, the aim of this PhD was to investigate the individual, social and environmental factors among the Mexican population, focussing mainly on the segment of the population with a higher intake of SSBs. This thesis consists of five studies, using a mixture of quantitative and qualitative approaches which address six interlinked research questions. The main findings (which have been reported and discussed in depth in previous chapters) are summarised below according to each of the research questions.

RQ 1: What is the association between sociodemographic factors and different classes of SSB consumers in Mexico? (Study1)

The analysis of a representative data set from 7,810 individuals (1->60 years) participating in ENSANUT-2012 showed that there were three classes of SSB consumers in the Mexican population: the “healthy SSB drinkers”, the “moderate SSB drinkers” and the “heavy SSB drinkers”. Females, children and individuals from low SES were more likely to be in the “Healthy SSB drinkers”, while adolescents and adults and individuals from medium and high SES were more likely to be in the "Moderate SSB drinkers" class. Adolescents and residents of Mexico City showed greater odds of being in the "Heavy SSB drinkers" class.

RQ 2: Is there an association between individual, social, and micro-environmental factors and SSB intake in a sample of Mexican adolescents? (Study 2)

Results indicated that habit, taste, parental modelling, home availability of SSBs and school availability of SSBs from vending machines were associated with the intake of SSBs. However, the association between vending machine SSB availability and the intake of SSBs was inverse for those in university compared to those in high school. Further analyses identified three classes of SSB consumers in this sample of adolescents: 1) the average SSB drinkers; 2) the moderate SSB drinkers; and 3) the heavy SSB drinkers. The findings also indicated that the association with different individual, social and meso-level factors varied depending on the amount of SSBs consumed. For instance, those adolescents classified as "average SSB drinkers" were more likely to be females, have higher SES but lower habit strength while those classified as "moderate SSB drinkers" were more likely to have higher habit strength and taste preference toward SSBs but lower SES. The "high SSB drinkers" showed even higher odds for habit strength than the "moderate SSB drinkers" and positive association for having SSB school availability via vending machines.

RQ 3: Are individual level theories (TPB and habit theory) useful to explain SSB intake in a sample of Mexican adolescents? (Study 2)

The data collected via an online survey showed that, consistent with TPB,attitudes and subjective norms to limit SSBs and PBC were associated with intention to limit SSBs. However, due to the lack of an association between intentions and SSB intake, it was not possible to fully test the TPB and to assess the moderation effect of habit in the relationship between intentions and the intake of SSBs.

RQ 4: What are adolescents' perceptions on how the home environment might play a role in the intake of SSBs at home? (Study 3)

Adolescents suggested that their parents played a key role within the home environment, particularly regarding the availability of SSB at home. However, among other facilitators of home availability were the beliefs that fruit-containing or flavoured beverages were healthy and the perceived ease of purchasing bottled SSBs. The taste of SSBs was not only perceived as a facilitator for home availability of SSBs but also was perceived as an important reason for adolescents to have and drink SSBs at home. Another important reason to have and consume SSBs at home was the belief that the intake of SSBs complemented Mexican dishes and fast food. Among other factors that prompted the intake at home were family influences, including parents, siblings and other close family members. The influence of the family was largely three-fold: 1) family preferences toward SSBs promoted the availability of SSBs, which in turn promoted intake; 2) drinking SSBs with family members was something that adolescents perceived to influence their beverage choices; and 3) lack of parental regulation and the difficulty faced by parents to maintain healthy beverage habits at home. Finally, some adolescents perceived that drinking SSBs was a family habit carried out for many years, which is mainly due to the constant availability of these beverages. This suggests that home availability of SSBs and drinking SSBs with food might act as a cue for intake within the home.

RQ 5: What are adolescents' perceptions on how the out-of-home environment might play a role in their intake of SSBs? (Study 4)

Four facilitators of the intake of SSBs were identified during the analysis: 1) SSB availability; 2) access to SSBs in the vicinity of homes and schools; 3) limited access to water in some schools and 4) dislike of tap water. Although school nutrition policies are currently in place across Mexico, participants reported that these policies were not fully implemented in their school. The study also showed that peers influence SSB intake at school in two ways: 1) peer drinking preferences toward SSBs influenced adolescents to drink them by initiating craving; and 2) social norms at school were a factor that possibly promoted or discouraged adolescents' intake of SSBs while at school. With regards to other out-of-home activities carried out in places different from school, six personal and environmental facilitators for SSB intake were identified: 1) wide access to purchasing SSBs 2) wide availability of SSBs within shops; 3) marketing of SSBs 4) eating out; 5) sweetness craving; and 6) the weather. Adolescents' SSB intake happened as part of social activities carried out with family and friends, such as going to the cinema and eating out, which could also be considered as contextual cues that, once encountered, trigger the intake of SSBs.

RQ 6: What are adolescents' perceptions and awareness of the current SSB tax? (Study 5)

Two years after the implementation of the SSB tax, adolescents were not aware of the SSB tax policy. Adolescents largely perceived that the tax would not affect their SSB intake, mainly due to the marginal increase in prices, taste preferences and 'addiction' to SSBs. The findings also provided some indication on possible substitution patterns, if adolescents in the sample were to reduce their SSB intake they said they would substitute SSBs with *aguas frescas*, 100% fruit juices, non-caloric instant-flavoured drinks and water.

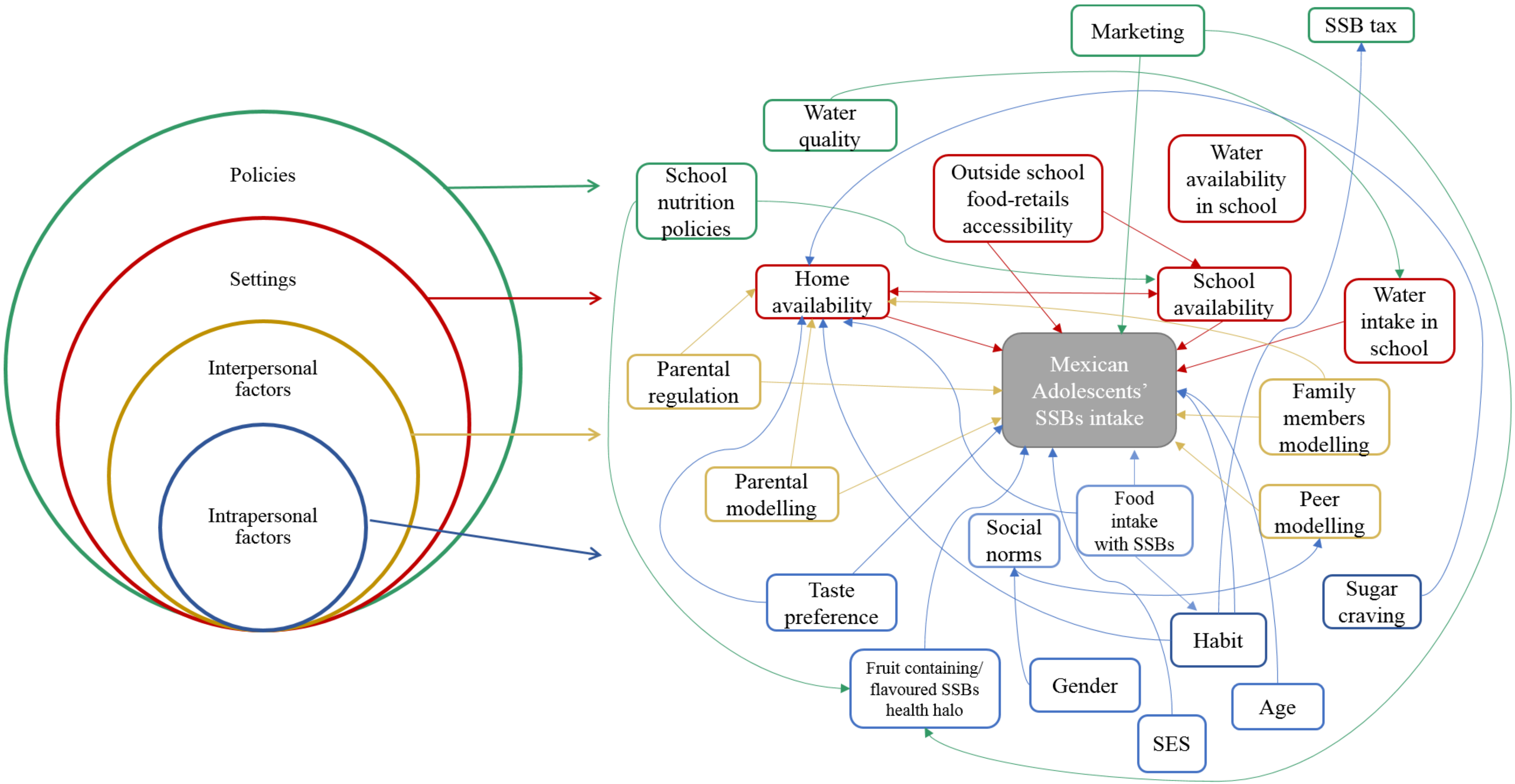
9.3 Implications of study findings for theory

The findings of this thesis have wide-ranging implications for theory, interventions, and policy, which are discussed in the following sections.The results from this thesis acknowledge that the socio-ecological model can be useful in conceptualising the intake of SSBs, as the qualitative chapters of this thesis made more explicit the possible connections between the different levels of influences (i.e. individual, social, meso-level and macro-level). However, the findings also underline the need for further research to identify theories for each level of influence to best explain the intake of SSBs.

9.3.1 Implications for the socioecological model

A socioecological model of food and beverage intake elaborated by Philipborn et al. (2016) (Figure 1.4) is useful to conceptualise the different levels of influence in relation to beverage intake. However, the model is vague as it does not account for the specific types of beverages or for a specific population subgroup (i.e. Mexican adolescents). Moreover, it does not provide any information about how the constructs/factors interact across levels of influence. Nonetheless, the overall findings from this thesis help to develop a more specific model for the intake of SSBs in Mexican adolescents (see **Figure 9.1**).

Figure 9.1 Socioecological model for the intake of SSBs among a sample of Mexican adolescents



The proposed model moves forward the use of the socioecological model to understand adolescents' intake of SSBs in Mexico, by providing more specific factors/constructs for each of the levels of influence that are relevant for the intake of SSB in Mexican adolescents. Nonetheless, future research could refine the proposed model (Figure 9.1) by adding other relevant theoretical constructs where appropriate, as well as testing the relationships among suggested factors with larger sample sizes (Glanz et al., 2008). Structural equation modelling (SEM) could be useful to test this associations and to account for direct and indirect effects among different factors/constructs. By doing so, a more robust model could be produced that would guide the development of multi-level interventions to reduce the intake of SSBs.

9.3.2 Implications for individual level theories

Part of the work presented in this thesis aimed to test if two individual level theories (TPB and habit strength theory) could explain the psychosocial aspects of SSB intake (Chapter 4). However, due to methodological problems, such as the use of an inadequate number of items to assess a construct of intention (discussed in detail in section 4.4.1), these theories could not properly be tested, and therefore could not be accepted or refuted to explain the intake of SSB among a sample of Mexican adolescents. Despite this limitation, habit was identified as an important construct at the individual level that is worthy of further investigation in relation to SSB intake. As discussed in section 2.2.3, dietary habits are the result of actions that are based on daily routines, potentially performed in a stable context, and require minimal cognitive effort and active decision making (van't Riet et al., 2011). Thus, conducting more research will help strengthen the role of habit in the intake of SSBs and could have various implications on the development of interventions (see section 9.4.1).

Robust research is needed before accepting or rejecting the use of constructs of TPB as part of the socioecological model for the intake of SSBs in Mexican adolescents. Apart from improving the measurement of TPB constructs, it could also be useful to conduct research on the predecessors of TPB constructs like behavioural beliefs, normative beliefs and control beliefs (see Figure 2.1).

Previous studies (Kassem et al., 2003; Kassem and Lee, 2004; Tipton, 2014b; Zoellner et al., 2012b) have conducted elicitation interviews among the target population in order to shed light on the different beliefs that drive attitudes, subjective norms and perceived control in relation to the intake or reduction of SSBs. By conducting this type of qualitative work it will be possible to development behavioural intervention to change those beliefs that are guiding intentions to drink SSBs (Ajzen, 2006).

9.4 Complex systems

The finding of this thesis suggests that a comprehensive and dynamic framework that considers several factors and levels is necessary to understand and reshape SSB intake. Complex systems science is a field that concern the understanding of complex systems (Shalizi, 2006), where complex systems are described as a "set of entities with relationships between them" (Finegood, 2012). Complex systems are characterised by multiple elements, a lack of predictability, interrelation among entities, feedback relations, causal loops and discontinuous non-linear relationships (Diez Roux, 2011; Finegood, 2012; Wang et al., 2015). By conceptualising SSB intake as a complex system, it is acknowledged that individual determinants of SSB intake do not work in isolation, but as a function of the dynamic interaction between genetic, physiological, social and physical environments and political factors (Diez Roux, 2011; Lee et al., 2017; Wang et al., 2015). However, before moving to understand the dynamic complexities of the intake of SSBs in Mexico, first it is important to understand the broad range of factors (ideally across a wide range of disciplines) that influence SSB intake. The results from this thesis add to the evidence by recognising diverse multi-level factors that contribute to the intake of SSBs in Mexico which is useful for future research aiming to apply complex system methodology, which according to the evidence is a promising strategy for public health (Wang et al., 2015). Understanding how these factors interact within a system can provide guidance on how to reshape these components in a favourable way that could contribute to reducing SSB intake (Rutter et al., 2017).

9.5 Implications for interventions

The Medical Research Council (MRC) framework for developing and evaluating complex interventions (Figure 9.2) proposes four stages to develop, evaluate and implement interventions systematically (Craig et al., 2008). The work presented in this thesis contributes to the developmental phase of this framework by identifying the existing evidence about the different factors that promote the intake of SSBs in Mexico.

Figure 9.2 Medical Research Council (MRC) framework for developing and evaluating complex intervention

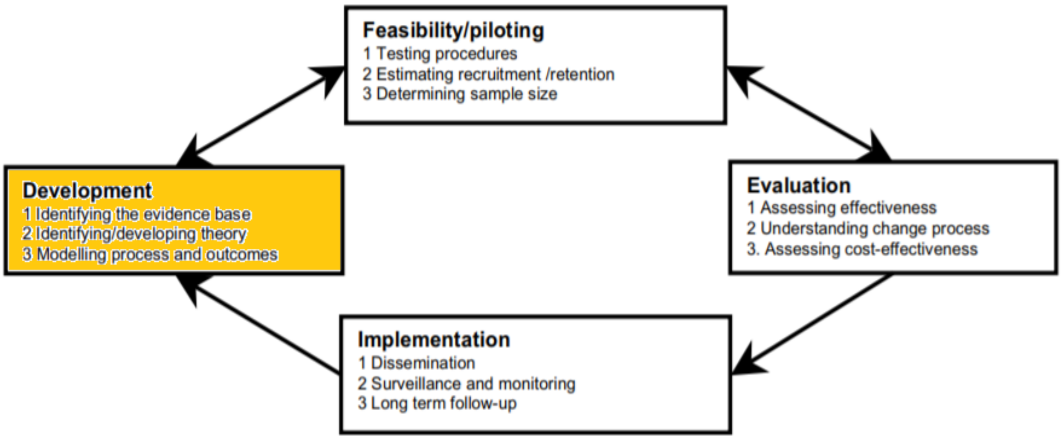


Figure from Craig et al. (2008)

Chapter 2 first presented evidence about the factors contributing to the intake of SSBs in different populations and countries but also highlighted the lack of evidence from Mexico, which guided the studies presented in this thesis. The findings identified different factors that determine the intake of SSBs in Mexico, which could be useful in the design of multi-level interventions to promote the reduction of SSBs in Mexican adolescents. Nonetheless, according to the MRC framework it is also important to identify what previous interventions have been carried out to promote a reduction of SSBs in Mexico and whether these procedures were effective (Craig et al., 2008).

In Mexico, no behavioural intervention to reduce SSBs intake has been conducted among adolescents. Nonetheless, four interventions among school-aged children and women were identified, which were aimed at reducing SSB intake (Hernández-Cordero et al., 2014; Rodriguez-Cano et al., 2015) and promoting water intake respectively (Carriedo et al., 2013; Elder et al., 2014). The limited number of interventions may stem from the fact that currently the public health agenda in Mexico has mainly been focused on policy implementation to tackle unhealthy behaviours at the population level. Although policy interventions are necessary to reach all population groups at the same time, the findings from this thesis provide important insights on the different factors related to SSB intake that could not be tackled solely via policy initiatives. It is argued that healthy behaviours are maximised when environments and policies support healthy choices, and individuals are motivated and educated to make those choices (Glanz et al., 2008), which is the reason why multi-level interventions are required. These strategies are also consistent with system thinking (discussed above) and highlight a need to intervene at multiple levels and in multiple ways in order to maximise the impact on public health. The following sections discuss in more detail the thesis' findings in relation to the development of interventions to reduce the intake of SSB among adolescents, by also incorporating the evidence of previous interventions conducted in other countries.

9.5.1 Behavioural interventions

Most behavioural interventions trying to change diet-related behaviours target the reflective or cognitive processes by providing information and imparting skills to increase the self-regulatory capacity to engage in the desired health behaviours (Marteau et al., 2012; Rothman et al., 2009). However, the findings from this thesis point out the relevance of automatic processes in the intake of SSBs. For instance, quantitative analyses suggested that habit strength was associated with the mean intake of SSBs and predicted the classification of adolescents in the higher SSB intake class (Chapter 4). On the other hand, qualitative analyses (Chapter 6 and 7) supported the notion that encountering certain environmental cues, such as home and school availability of SSBs, meals at home, eating out occasions, visiting supermarkets and different social activities, may also trigger the intake of SSBs. According to the habit literature, there are two principal ways by which habitual behaviour can be targeted in an intervention. First, is the disruption of the current habit which, according to Lally and Gardner (2013), could be achieved by discontinuing the exposure to habit cues, in this case home and school availability, meals at homes, eating out occasions, supermarkets and different social activities. However, removing adolescents from some of these cues could also represent an almost impossible task as it would involve stopping selling SSBs in food retail including restaurants. Nonetheless, it has been suggested that modifying contextual cues in relevant environments by using choice architecture (or nudging), that is altering placement (availability and proximity) or properties (sizing, label, presentation) of objects in specific environments (Hollands et al., 2013), could have an impact in habit disruption (Lally and Gardner, 2013; Salvy et al., 2018). Choice architecture is further discussed in sections 9.5.2 and 9.6.3.

Secondly, the formation of healthy habits may contribute to the disruption of the unhealthy habits. Habit formation is achieved by repeating the desired behaviour in a stable context until it becomes automatic (Gardner et al., 2014; Stawarz et al., 2015). Thus, promoting a habit formation for water intake could be a feasible intervention to reduce SSB intake among adolescents. Based on previous interventions that involved habit formation (Carels et al., 2014; Judah et al., 2013; Stawarz et al., 2015), Table 9.1 outlines effective techniques used to form new habits that could be useful for the reduction of SSB intake.

Table 9.1 Actions that could be included in a habit formation intervention for adolescents

Actions
1. Existing routines can be used to prompt actions this are called event-bases tasks (i.e. drinking water before each class) and are easier to remember than time-based tasks (i.e. at 10am every day I need to drink water). External memory aids, in the form of reminders, can support implementation intentions by connecting drinking water with an existing routine and turn it into an event-based task, i.e. Everytime that I encounter an eating occasion, I will serve and drink a glass of water (Carels et al., 2014; Judah et al., 2013; Stawarz et al., 2015)
2. A motivation intervention to persuade people about the benefits of water intake. This can be in the form of talks, social media, etc. In this way they can build more positive attitudes toward water intake which could aid the repetition of the behaviour (Judah et al., 2013)

Therefore, a behaviour change intervention to reduce SSBs is vital to focus on both disrupting the existing habit to drink SSBs and forming a new desirable habit , such as drinking water (Lally and Gardner, 2013; McGowan et al., 2013). A strength of habit formation interventions is their capacity to maintain the new habit beyond the intervention period (Gardner et al., 2014), which is the reason why habit formation needs to be considered for the development of multi-level intervention.

9.5.2 Intervening in the home environment

The results from studies 2 and 3 identified the home environment as fundamental in the intake of SSBs among adolescents, and a number of home factors were suggested that are associated with SSB intake and that could be modified through an intervention. A recent systematic review and meta-analysis of interventions aimed to reduce the intake of SSBs (Vargas-Garcia et al., 2017) concluded that greater reductions of children's SSB intake were observed in interventions at home settings than in school settings. This indicates the importance of directing efforts to the home environment to prompt changes in the intake of SSBs. In line with the disruption of habits discussed in the previous section (9.4.1), home-based interventions should first focus on modifying the home environment in a way that directs household members toward healthy choices and then towards educating individuals to maintain healthy food environments at home.

9.5.2.1 Changing SSB availability and accessibility at home

Home availability of SSBs was associated with the intake of SSBs among adolescents and also predicted high and moderate intake among adolescents (Chapter 4). Further, the availability of SSBs at home seemed to interact with the intake of SSBs at school (**Figure 9.1**). Therefore, interventions aimed at changing SSB availability patterns at home could impact upon adolescents' SSB intake at school as adolescents would be unable to take SSBs to school as a way to compensate for the sale restriction at school.

The results presented in Study 3 suggest that parents and other family members who act as household gatekeepers (i.e. grandparents, aunts/uncles) are important facilitators of SSB availability at home. Therefore, future interventions could be directed to household gatekeepers with the following objectives: 1) to educate them about what type of beverages should be available and accessible in the household (i.e. plain water, non-caloric beverages), 2) to clarify any misconception of fruit-containing beverages; and 3) to inform and demonstrate the healthy preparation of homemade beverages (i.e. reducing the amount of sugar during the preparation of *aguas frescas*).

Furthermore, most adolescents lacked regulation at home that could limit their access to SSBs. According to the results of study 3, parental regulation might depend on parental and family health consciousness. Therefore, an intervention could seek to increase health consciousness among parents in order to impact SSBs access and availability patterns in the household through food rules. Although modifying SSB rules in the household could represent a good strategy for the reduction of SSBs, as well as for the prevention of high intake among young family members, previous evidence has pointed out that disapproval from parents is associated with a decreased intake among pre-adolescents and early adolescents, but not mid- adolescents (Luszczynska et al., 2013). Thus, the question remains about whether changes in parental regulation can influence older adolescents and young adults' SSB intake at home, as these age groups are likely to be more independent and less likely to be affected by parenting styles (Spear and Kulbok, 2004). Nonetheless, Melbye et al. (2016) suggested that although peer influences tend to be more significant during adolescence, as long as adolescents and young adults live at their family home they will still be strongly influenced by their parents' behaviours and attitudes. This represents an opportunity for interventions to target parents and other influential family members in order to reduce adolescents' SSB intake.

Previous interventions in the U.S. have tried to modify SSB intake and availability at the household. For instance, one household cluster-RCT aimed to change food choices at the household and individual level by providing group sessions to all household members who were over 12 years old (French et al., 2011). Sessions consisted of behavioural education, interactive activities, PA and healthy snacks and behavioural strategies such as goal setting (via household goal sheet), self-monitoring (self-monitoring booklet) and positive reinforcement. However, after 6 months of intervention there were no changes in household food purchases (mean difference = -0.19, p=0.39) or food availability (mean difference = 13.9, p=0.35). In contrast, other RCT only targeted pre-schoolers' mothers with the aim of changing children's and mothers' diets (including reducing SSB intake), as well as mothers' parenting behaviours (Østbye et al., 2012). For eight months, the intervention arm received interactive kits and telephone coaching sessions providing instructions on parenting skills, stress management and education on healthy behaviours. After the 22-month follow up, no changes in availability of healthy food in the intervention group, compared to the control group. However, mothers in the intervention group decreased their intake of SSBs (−5.78 oz vs.−2.24 oz; p=0.03), but no differences were found in children's intake of SSBs.

Evidence from previous interventions indicates that intervening among all household members poses a challenge, as the household is normally constituted by individuals from different age groups, beliefs and priorities. On the other hand, targeting mothers, who are known to influence children's dietary behaviours by transmitting attitudes and values about food items (French et al., 2011) seems to be more sensible. This is because positive changes in maternal behaviour could imply that children are exposed to adaptive behaviours, which in the long-term can lead to healthier decisions with regards to food intake (Østbye et al., 2012). Evidence from interventions involving parents of older adolescents or young adults is virtually non-existent, which presents an opportunity for further research to assess the feasibility of this type of intervention. In the case of Mexico, this need is confirmed by findings from this thesis, which suggested that targeting parents or any family member who acts as the household gatekeeper or agent of change, could represent a promising way to reduce intake of SSBs, mainly by promoting changes in the food environment at home.

9.5.2.2 Changing food and SSB relationships at home

According to the results from Study 3, the main reason it is important to have SSBs at home is that they complement food intake. As discussed in Chapter 6 (Section 6.3), there are cultural norms about accompanying savoury foods with sweet beverages among the Mexican population. These are deep-rooted behaviours that will be very difficult to change. This opens up questions with regards to how this can impact the development of an intervention. Considering that modifying this cultural culinary rule can take years or even generations, an intervention could focus on promoting substitutions of caloric SSBs with artificially sweetened beverages (ASB). In this way, the combination between sweet and savoury would remain, but the calorie intake would be reduced, which could have a more direct impact on weight gain. To a certain extent, this is already embedded within the aims of the current SSB tax, to indirectly guide the consumer to purchase either bottled water or ASBs (products that are not affected by the taxation). However, to date no evidence is available to corroborate that people are indeed substituting SSBs with ASBs and no additional efforts have been made to direct consumers towards this kind of substitution.

It is important to highlight that substitution trials have provided some evidence regarding the effect of ASBs on weight gain. For instance, Ebbeling et al. (2012) conducted an RCT among 224 U.S. overweight and obese adolescents. The intervention involved the delivery of water and ASBs to the home of adolescents for a period of one-year, monthly motivational calls to parents and three check-in visits, while the control group only received supermarket gift cards. At the end of the trial, the intervention group showed a decrease in BMI compared to the control group (-0.57 kg/m^2, p= 0.045), however the difference between groups was not maintained in the 2-year follow up (-0.30, p=0.46). Differences in SSB intake between the intervention and control groups was -0.7 servings/day ($p<0.001$) at 1 year and -0.4 serving/day (p=0.005) at two years. Similarly, de Ruyter et al. (2012) conducted a double-blind RCT among Dutch children for 18 months. The intervention group received daily disguised 8oz. cans of diet beverages at school, while children in the control group received 8oz. cans of SSBs. No data were presented regarding changes in beverage intake; however, after 18 months children in the intervention group increased their mean BMI z-score by 0.02±0.41 units, whereas the control group by 0.15±0.42 units. The mean difference between the groups was -0.13 (95% CI: -0.21, -0.05; p=0.001). Substitution trials are scarce, but according to two systematic reviews these types of trials were found to be the most rigorous according to quality assessment on randomisation methodology and the robustness of the process (Avery et al., 2014; Malik et al., 2013)

It is important to highlight that there have been concerns in the literature about recommending ASBs in place of SSBs, as it has been suggested that they could trigger two compensatory mechanisms that could hinder the reductions of caloric intake (Pepino, 2015). Intake of ASBs could stimulate the sweet taste receptors which are known to increase appetite and preferences for sweet taste and to modulate gut hormone secretion that affects energy reduction (Mattes and Popkin, 2009; Pepino, 2015). Also, ASB intake can result in overconsumption of food due to an awareness of their lack of caloric content (Borges et al., 2017; Burke and Small, 2015; Mattes and Popkin, 2009). Both mechanisms could represent a barrier for reducing calorie intake. Nonetheless, the current evidence on this topic in relation to ASBs and non-caloric sweeteners has been inconclusive due to potential conflicts of interest with the food industry (Borges et al., 2017) and the possibility of reverse causality (Laverty et al., 2015). For instance, the artificial sweeteners industry has sponsored original research as well as systematic reviews, suggesting that funders introduced bias affecting research outcomes and possibly undermining the quality and transparency of the findings (Mandrioli et al., 2016). Additionally, reverse causality has been proposed as another possible reason for the inconclusiveness of findings in relation to weight gain and the use of non-caloric sweeteners. This relates mainly to those individuals who chose to consume food and beverages with non-caloric are the ones at higher risk of weight gain (Laverty et al., 2015; Mandrioli et al., 2016).

In Mexico, promoting the substitution of SSBs with ASBs is in line with the strategic objective of the National Agreement for Healthy Nutrition (ANSA) (see section 2.4). Still, no substitution trial or any type of evidence is available to suggest that ASBs do not contribute to weight gain among the Mexican population. A limitation for conducting a substitution trial among Mexican adolescents involving ASBs is the belief that non-caloric sweeteners are health detrimental, especially when recommended to children and adolescents. The inconclusiveness of the evidence has fomented the wrong impression about non-caloric sweeteners (Carocho et al., 2017). Thus, more evidence is needed to support the notion of ASBs as an ideal substitute for SSBs before any further development of a substitution intervention is conducted or general nutrition recommendations are re-evaluated.

9.5.3 School-based interventions

Schools and universities are the places where adolescents spend most of their time during the week, and therefore have been a setting where a number of interventions have been conducted (Bacardi-Gascon et al., 2012; Carriedo et al., 2013), as schools offer the opportunity to easily reach young people (Vézina-Im et al., 2017). According to the findings from Study 4, the availability of SSBs at school was a facilitator of SSB intake. Nonetheless, it is important to consider that school nutrition policies currently implemented in Mexico have the potential to promote SSB-free schools, as long as these are well implemented and periodically evaluated. However, as discussed in section 7.3, a limitation that needs to be considered is that these policies target what is sold on school premises however they do not have control over what adolescents bring from home or purchase outside of school. Therefore, a potential way to complement the environmental changes induced by policies is through school-based behavioural strategies. Based on the results from this thesis, the next two sections discuss potential school-based strategies that can lead to a reduction in SSBs.

9.5.3.1 Changing social norms regarding SSB intake at school

The results from this thesis (Chapter 4 and Chapter 7) indicate that friends and peers at school played a role in the intake of SSBs via the following pathway: by seeing others consume SSBs (peer modelling) cravings were triggered causing other adolescents to also drink SSBs, however this can also be influenced by social norms established in a given social group. School-based interventions could prompt changes in beverage-related social norms through a peer-led intervention.

This type of intervention has the potential to incorporate two behaviour change techniques, namely modelling of the behaviour by drinking plain water (Abraham and Michie, 2008; Cane et al., 2015) and information about others' approval (Cane et al., 2015), which may have the potential to change social norms and create a healthy beverage environment at school. No previous peer-led intervention was found to have been conducted in Mexican schools, however a four-arm quasi experimental trial in Canada aimed to reduce intake of SSBs among adolescents (14 years) through a 6-week classroom nutrition educational sessions delivered by multiple peer educators [older peers (recent nutrition graduates), cross-age peers (nutrition undergraduate students) and same age peers], and single older peer educator while controls (2 groups) were self-taught (Lo et al., 2008). The authors reported that the results suggested that adolescents in the multiple peer educator groups, in comparison with the single peer and the control groups, decreased their intake of SSBs after 6 weeks and maintained it for 3 months but did not provide any data to support this statement. A further study by Smit et al. (2016) aimed at promoting water drinking among children by incorporating peer-led strategies, consisting of the most influential children in the classroom who promoted water consumption among their peers for eight weeks. Children allocated in the intervention group reported an increase in water from the baseline to follow up (2.67 to 2.92 score points, $p=0.01$) compared to those in the control group who did not receive any intervention (2.37 to 2.27 score points, $p=0.36$). Collectively, these findings highlight that this type of intervention can be effective and well received and therefore might be an important component in a multi-level intervention targeting SSB intake among adolescents.

9.5.3.2 Interventions to promote water intake during school hours

As part of the strategies for promoting healthier food environments at schools, the active promotion of water intake should be the primary message delivered to students via an intervention. As discussed in Section 7.3, despite water provision policies and their barriers (discussed in section 9.6.1), a school-based intervention could contribute in normalising the intake of water in school.

Drawing upon previous school interventions aimed at promoting water intake in schools (James et al., 2004; Loughridge and Barratt, 2005; Muckelbauer et al., 2009), two quasi experimental studies conducted in Mexico were found to have implemented water promotion strategies among children. Firstly, Carriedo et al. (2013) used social marketing strategies in four primary schools in Mexico (children aged 9-10 years) for a period of three months. The strategies included the provision of filtered water bottles (20 litre bottles) in strategic locations around the school and reusable plastic water bottles of 750 ml with markers that illustrated the amount of glasses. Moreover, educational videos, provision of individual and poster size "*pipimetros*" or pee-meters (an illustration that shows the different yellow shades of the urine that correspond to the amount of water consumed in a day) were used as intervention materials. Teachers and parents were involved in the intervention by also giving them bottles and materials by which they could also promote water intake to children. After three months, the proportion of children who used water bottles increased by 20% in relation to the control group and the proportion of children never filling water bottles at school decreased by 43% ($p<0.001$). Moreover, results indicated that soda intake decreased in both the intervention and control arms, however, the reduction was higher in the intervention group (-6.8 vs -2.0 percentage points, $p<0.05$). In terms of behavioural changes, the intervention arm showed higher improvement in attitudes towards the intake of water, subjective norms with regard to family water intake (importance of drinking what parents say and importance of family drinking water) and self-efficacy to use the water bottles and the "*pipimetro*". A limitation however was that water intake showed no changes outside of school hours, which indicated that promotion should also be expanded outside the school environment.

The second quasi-experimental trial was simultaneously conducted in Mexico and in the U.S.A. (among Mexican-Americans) and consisted of the implementation of a programme that promoted water intake among low SES children (Elder et al., 2014). Components of the intervention varied slightly depending on the country, but both included the distribution of water bottles, "*pipimetros*" posters in the toilets, provision of take-home materials for parents and class activities around water intake. The intervention did not provide water to schools in Mexico as each classroom already had a filtered 20-litre water bottle that was funded by parents. After five weeks the intervention group located in Mexico showed an approximately 30% increase in water intake at lunchtime (which is the snack consumed midmorning at school). However, no follow up information was available to see if the increase in the intake was maintained for a longer period of time.

The results from these trials in Mexico are consistent with findings from other trials conducted in other countries (James et al., 2004; Loughridge and Barratt, 2005; Muckelbauer et al., 2009), indicating that the promotion and provision of drinking water could increase its intake. An important consideration in the evaluation of this type of interventions in Mexico, is that outcome measurements, in this case water intake, were self-reported by children, which might potentially be biased especially because children were aware that the intervention was aimed at increasing water consumption. Thus, more objective outcome measures are needed to ensure that children are really increasing their water intake (see section 9.6.4.1). Although both trials conducted among Mexican children included parents and teachers, this type of intervention needs to be extended to all members of the school environment, especially to those who interact with students (i.e., administrative personnel, directors etc). In this way, any adults present in the school environment can serve as role models. Finally, water promotion and provision interventions had not been conducted among Mexican adolescents, so less is known about whether the strategies previously used in children, namely bottle provision and education sessions and modelling, would also be effective in increasing the intake of water in schools in older populations.

Overall, Mexico urgently needs multi-level interventions to reduce the intake of SSBs. As such, results from this thesis provide initial guidance as to what needs to be considered when developing a multi-level intervention. The socio-ecological model could serve as the basis for the intervention with all potential interventions (habit disruption and formation, home based interventions, peer-led intervention) implemented simultaneously to enhance their effectiveness. If this were to be done, it would be anticipated that changes in one environment could support changes in other environments. A drawback that is important to consider when developing multi-level interventions, however, is the difficulty in changing actual policy (Lane et al., 2016). In the case of Mexico, nonetheless, the macro-level or policy environment is already making efforts to implement and maintain food policies to direct the Mexican population towards healthier food environments, representing a great advantage for the field of public health nutrition.

9.6 Implications for public health policy

Food policies can affect the likelihood of people consuming and purchasing healthier foods instead of unhealthy foods (Peeters, 2018). Due to the increase in the prevalence of obesity, there has been a worldwide trend of introducing food policies with the objective of modifying food environments and orienting populations towards a healthier diet. Among others, these food policies involve SSB taxes, school nutrition policies, nutrition labelling and the provision of nutrition education (Hawkes et al., 2013).

As presented in Chapter 2 (Section 2.4), since 2007 food policies have been pursued (Moise et al., 2011), yet it was not until 2011 that Mexico introduced school nutrition policies (Monterrosa et al., 2015) and in 2014 with the passage and implementation of the tax on SSBs when food policies began to take more importance. Mexican policy makers and governmental bodies have placed various efforts on implementing different food policies at a national level. A weakness of these efforts, however, is the lack of evaluation of these different policy strategies, especially the school nutrition policies. Therefore, it is a timely moment to promote policy evaluation that could reinforce and improve existing food policies but also inform about new strategies that could also contribute to healthier food environments. This section discusses the implications the findings of this thesis both for existing policies and for, potential new policies.

9.6.1 Implications for the SSB tax

Systematic reviews (Cabrera Escobar et al., 2013; Green et al., 2013) and evaluation studies on the effect of taxation (Alvarado et al., 2017; Caro et al., 2018; Colchero et al., 2017b, 2016; Falbe et al., 2016; Nakamura et al., 2018) have consistently suggested the potential of fiscal policies to reduce the purchase of SSBs. The tax has the potential to produce four favourable outcomes: 1) households would consume lower amounts of SSBs (Brownell et al., 2009; Dharmasena and Capps, 2012); 2) shift consumption of SSBs to water or other beverages that do not contain added sugar; 3) tax revenues could be used to fund programs to prevent obesity and provide free drinking water at schools (Campos, 2018) and 4) socio-economic groups at risk of obesity (low SES) could be more likely to be responsive to price changes of SSBs, thus strengthening the public health impact of an SSB tax (Sugovic, 2014).

Notwithstanding, it is important to highlight that four years after the tax implementation in Mexico, very little is known about whether the tax has produced changes in the expected outcomes. There is evidence suggesting that, at least at household level, a decrease in the purchases of SSBs has taken place (Colchero et al., 2016), however the effects of the SSB tax on the intake of SSBs (either in ml or in calories) and which group of the population has decreased their purchases more (children, adolescents or adults), is still unknown.

With the exception of the qualitative findings from this thesis, which suggest that consumers will substitute SSBs with water, *aguas frescas*, and non-caloric beverages, no other study has explored the substitution pattern caused by taxation. Beyond this, there is no evidence to demonstrate that tax revenue has been used to fund obesity programmes, or whether improvements in the supply of clean and palatable water in schools has taken place. A recent media article suggested that between 2014 and 2017 more than 82.6 billion pesos (~ 31 billion British pounds) were collected via SSB tax revenues (Campos, 2018). However, according to data provided by the Secretary of Finance, not even 10% has been used for the implementation of potable water in schools (Campos, 2018). Finally, the results from Study 1 and 2 suggested that medium and high SES Mexicans were among the heaviest consumers of SSBs, which rejects the notion that tax will affect those who consume more SSBs. This thesis acknowledges issues around the SSB tax specifically by highlighting its limitations and by exploring how the SSB tax needs to be improved in order to make adolescents more sensitive to taxation. The following sections expand on the discussion presented in Section 8.3 about how to improve the SSB tax policy in Mexico.

9.6.1.1 Tax framing

Study 3 suggested that the SSB tax has been less salient among adolescents, which may be a reason why adolescents seemed reluctant to comply with the price increase of SSBs (Leicester et al., 2012). Policy makers, as well as members of advisory committees involved with the SSB tax, should consider designing and implementing a tax-framing strategy directed to different sub-groups of the Mexican population with the objective of informing them about the tax policy. It is argued that how the tax is framed will evoke different psychological responses and therefore affect the tax outcomes differently among different population groups (Cash and Lacanilao, 2008; Leicester et al., 2012; Sugovic, 2014). Based on previous evidence, Table 9.2 summarises potential framing strategies that policy makers could consider when promoting tax acceptance among adolescents, which at the same time can elicit the rationalisation of beverage choices.

Table 9.2 Potential SSB tax framing strategies for adolescents

Action	Description
Change label attached to tax	Choose a different label different from tax to refer to the increase of price. Ideally a label that people could associate as benefitting from (i.e. sugar surcharge)
Earmark tax	Refers to labelling the tax policy as beneficial for obesity prevention which will increase the willingness to pay
Stigmatise SSBs	The tax could be accompanying with stigmatised label by communicating negative information to the consumer about the product, such as poor quality, harmful effects, or even social undesirability. Tax-induced stigma can reduce consumption of the product, thus amplifying the effect of the tax.
The messenger	This refers to how the person,group or people providing the information to consumers can affect how people respond to it. For instance, in the cases of adolescents the messenger would need to be a personality that is well accepted by adolescents (i.e. famous personality) and not someone who is not (i.e. government).

Adapted from (Hill, 2010; Sugovic, 2014)

Food taxes have two contrary objectives, one is to raise money in the form of revenues and the other is to change behaviour (Hill, 2010). Thus, tax framing will depend on what the government expects the taxation to achieve. For instance, if the government is interested in the economic aspect of the tax (i.e. revenues to finance obesity programmes), then earmarking would be more appropriate. In contrast, if the interest is on preventing people from buying SSBs, which appears to be the case in Mexico, then applying stigmatising labels, similar to smoking policies, would need to be considered. Before applying any of these strategies however, more formative research needs to be carried out across Mexican population groups with different socio-demographic characteristics, in order to empirically assess whether any of these strategies would be feasible among the Mexican population.

9.6.1.2 Increase in the tax rate

An important finding of this thesis is that adolescents perceived that an approximately 10% increase in price was not enough to discourage their purchases of SSBs. This finding, together with modelling studies (Barrientos-Gutierrez et al., 2017; Sánchez-Romero et al., 2016), provides a straightforward recommendation to policymakers to increase the tax rate. By maintaining an insufficient tax rate, that is not salient or relevant to consumers, especially to adolescents from medium to high SES who are the ones that are more likely to drink higher amounts of SSBs, the effect of the tax could be hindered.

9.6.2 Implications for marketing regulations

As presented in Chapter 2, the beverage industry in Mexico has bombarded adolescents with TV and printed advertising. This is the reason why in 2014 the government implemented a regulatory policy that restricted the marketing of energy dense foods and SSBs on TV and cinemas between 14.30 to 19.30 Monday-Friday and 7.00 to 19.30 during weekends (Comision Federal para la Proteccion contra Riesgos Sanitarios, 2014). However, other forms of marketing have yet not been controlled, such as marketing at the point of sales (Velasco et al., 2016), on public transport (Martínez Espinosa, 2017) and on social media (Hernández-Chávez et al., 2017).

Section 6.3 of this thesis briefly discusses how findings from Study 3 relate to the marketing of SSBs. For instance, beliefs on the healthiness of fruit-containing SSBs may have been the result of the misleading marketing that these beverages received, making consumers believe that they are 100% fruit and natural, without acknowledging the amount of added sugar (Calvillo, 2014; Calvillo et al., 2014).

Additionally, marketing in restaurants, cinemas and stadiums appeared to contribute significantly to construct the association between certain foods with SSBs (i.e. popcorn and soda, fast food). A marketing strategy from the beverage industry in low- and middle-income countries (including Mexico) is to sponsor independent shops and restaurants by providing fridges, tables, chairs, tents and paint work. This type of marketing directs consumers to choose the SSB that is being promoted in a specific place. Therefore, marketing policies must be extended to all media platforms, especially to those on the internet like social media, which are highly frequented by Mexican adolescents (Instituto Nacional de Estadistica y Geografia, 2018; Pacheco Amigo et al., 2018)

The beverage industry is extremely influential in Mexico (Taylor and Jacobson, 2016), which is likely to make it difficult to implement any marketing strategy that restrict all publicity. The beverage industry is known to provide jobs, as well as improve the country's economy (Zazueta, 2012), which poses some challenges for governments and policy makers to go against them. On the other hand, Mexico is a deeply corrupt country, and there is public knowledge about alliances between the beverage industry and politicians[8], which has and will continue to represent a challenge for the implementation or modification of policies that directly affect the beverage industry, such as marketing.

9.6.3 Neighbourhood food environment

According to Lake (2018), the neighbourhood food environment (which is not limited to residential areas) is defined as a combination of retail outlets (supermarkets, convenience stores), restaurants and take-away outlets. The results from Study 4 suggested that the wide availability of SSB options in convenience stores and minimarkets not only facilitated adolescents' intake of SSBs, but also expanded their SSB options in terms of products offered, indicating that the neighbourhood food environment could be contributing to the intake of SSBs. Controlling the availability of SSBs in retail outlets could represent an impossible task, as the beverage industry plays a major role in assuring the availability of

[8] It is acknowledged that former president Vicente Fox— who prior to the presidency was former Coca-Cola CEO— facilitated the provision of soda to disconnected rural communities in Mexico

their products in national and transnational supermarkets and, to a certain degree, in small independent convenience stores. For instance, in Mexico, it is known that Coca-Cola and Pepsi-Cola offer “free” equipment (i.e. refrigerators) and paint work (alluding the colours and logo of the company) to independent shops in exchange to sell their products (Rosenberg, 2015). This might be highly appealing to shop owners, as these types of shops tend to be more common in rural areas and disadvantaged neighbourhoods. Therefore, other alternatives are needed to counteract the availability of SSBs in food retail. A potential alternative is choice architecture or nudge interventions in retail outlets. Choice architecture in the field of public health nutrition includes changes in the food environment that direct consumers towards healthier food choices. Among these efforts are alterations to the placement of foods in micro-environments, including supermarkets and shops (Hollands et al., 2013). This could consist of placing less healthy foods (SSBs) further away from customers to make them less accessible and placing healthier food options (e.g. water and ASBs) in optimal positions to influence consumers to select them (Hollands et al., 2017).

To date, no research or intervention in Mexico has targeted the placement of SSBs or any other energy-dense foods, indicating the need for formative research to inform the feasibility of this type of intervention in the Mexican context preliminary to any policy suggestion. A systematic review of interventions focussing on positional changes of food in micro-environments (home, workplace and cafeterias but not in retail stores) suggested that although evidence is still scarce, positional nudges can have an effect on food choice sales and intake (Bucher et al., 2016). However, a more recent systematic review of RCTs aimed at changing food purchases in grocery stores, found that interventions that altered the store environment through advertisements, item placements, increased visibility and taste testing of healthy products showed mixed effects in food purchasing (Hartmann-Boyce et al., 2018).

9.6.4 Implication for the education sector

The Ministry of Education is a federal authority responsible for overseeing the development and implementation of national educational policy and school standards in Mexico. As described in Section 2.4.1, the Ministry of Education was involved in the development of current nutritional policies. For this reason, any recommendation to improve current school nutritional policy should mainly target this institution.

9.6.4.1 Provision of water

The findings from this thesis show that free water is not always available in schools and in the out-of-home environment. Despite recent policies stating that the use of SSB tax revenues would be used to install water fountains with a filter system in all schools nationwide (Diario Oficial de la Federacion, 2015), no evidence is available to support this having been implemented in schools since the tax was implemented.

The implications for policy on this matter will be to first ensure that the Ministry of Finance used the money to facilitate the availability of water in schools. Secondly, based on qualitative findings from this thesis suggesting that the taste of tap water represents a barrier to drinking water in schools, availability might not be the only solution to direct adolescents towards drinking the water provided. The water available needs to be safe, palatable and to have the desirable temperature. Water safety in Mexico is still is a problem (Ortega-Castaneda and Vega, 2016) and despite improvements over the years there is a common belief among the Mexican population that drinking tap water is unsafe and could be detrimental to health (Espinosa-Montero et al., 2013). It is therefore important to periodically monitor microbiologic and chemical purification to prevent any type of contamination, as well as to inform students and school personnel about the safety status of the water they are drinking. Filtering mechanisms and water temperature could improve the taste, however the legislation documents do not address the temperature of water provided (Diario Oficial de la Federacion, 2015). This is an important factor that needs to be considered as in some regions in Mexico temperatures can reach 40°C, so it is likely water at room temperature would not be appealing to students.

Evaluation of the effects of providing water on the actual water intake needs to be conducted, in order to assess its effectiveness, and to gather sufficient evidence that installing clean and safe water fountains could increase water intake and expand this policy out to worksites and public spaces. Drawing upon the intervention by Muckelbauer et al (2009), installing flow meters to all the water fountains could be a feasible way to measure the amount of water that has been dispensed during a day in each school.

9.6.4.2 Improving school food policies

Policies which restrict the sales and the preparation of unhealthy food in educational institutions are crucial to improving the food environments in schools and preventing unhealthy weight gain (Driessen et al., 2014). However, the findings from Study 4 suggest that in Mexico as the educational level of the school increases, adherence to policy begins to decline. This indicates that individuals are not exposed to healthy food environments in school throughout all their formative years. Apart from the findings from Study 3 of this thesis, one more published study by Lopez-Olmedo (2016) (described in Chapter 2.4.1) has evaluated the adherence and effects of school nutrition policies in Mexico, suggesting children’s lower energy intake in schools after the implementation of nutrition policies. Thus, more research is needed before concluding effectiveness of school food policies in Mexico.

A recent systematic review and meta-analysis of interventions that target in-school food policies (mostly conducted in the US and the UK), specifically those strategies that restrict specific products like SSBs and unhealthy snacks, standards on nutrients, portion size and/or calorie intake, suggested that these policies had no pooled effect in-school SSB intake, total calorie intake, overweight and obesity (Micha et al., 2018). The lack of effect of school food policies on SSB intake and weight and calorie intake could be due to energy compensations made in the household (Lichtman-Sadot, 2016) and/or the access to SSB in the vicinity of the schools (Driessen et al., 2014). Nonetheless, it is important to consider that school environments and policies vary significantly across countries, so it is unclear to what extent findings from other countries are applicable to Mexico.

9.6.4.3 Policies to modify the food environment around schools

Findings from Study 4 also suggested that the access that adolescents have to various food outlets (i.e. cafes and restaurants, street vendors) near their school serves as an alternative when there are limited food options at school and as a social activity among peers during and after school hours. This not only undermines the effort made by school policies but also presents adolescents with various opportunities to access SSBs and other unhealthy foods (Smith et al., 2013). The results of study 4, as well as other empirical studies (Seliske et al., 2013; Vine and Elliott, 2014), suggest that there is a relationship between the distance to food outlets and the purchase and intake of SSBs. Therefore, a policy should restrict the establishment of food outlets or street vendors that sell unhealthy foods within a certain distance of educational institutions. Although a previous study in Mexico (described in sections 2.3.3 and 2.3.4) used geographic information system (GIS) to locate retail food outlets near schools (Barquera et al., 2018), no information is available with regards to the distance to schools or about density of these shops around each school. Therefore, more spatial research is needed in Mexico to assess whether distance and density of food outlets are associated with intake of SSBs, in order to support any policy that aims to restrict placement of food outlets near schools. A major drawback of any policy or intervention aiming to change the food environment is the practicality of acquiring food and beverages on public roads in Mexico (Shamah-Levy et al., 2011), where informal food outlets, such as food mobile vendors, are abundant. Restricting the placement of mobile vendors could mean a cut of number of informal jobs, which will impact upon the economy and potentially aggravate poverty.

Overall, food policies in Mexico are slowly being forged by the implementation of different mutually reinforcing policies (Peeters, 2018). In addition, what Mexico is doing in terms of food policy is in line with the NOURISHING [9] framework, which proposes a clear guideline to improve dietary behaviour by

[9] NOURISHING is a systematic framework that comprises three broad domains of policy action: food environment, food systems and behaviour change communication, in order to tackle unhealthy diets and prevent obesity (Hawkes et al., 2013).

seeking the implementation of policies to modify availability, affordability and acceptability of healthy diet (Hawkes et al., 2013). However, as previously discussed, improvements in the evaluation of existing policies and further research is needed to help pursue the implementation of food policies that have not yet been consolidated, such as marketing and planning restrictions on food outlets (Hawkes et al., 2013).

9.7 Strengths and limitations

Strengths and limitations of each individual study have been discussed in detail in Chapters 3 to 8. This section aims to discuss the overall strengths and limitations of the thesis.

9.7.1 Overall strengths

This thesis contributes to the literature by providing the first socio-ecological exploration of the intake of SSBs in Mexico. First, where attention and efforts have been mainly directed towards food policies, research presented in this thesis provides new knowledge about the individual, social and environmental factors associated with SSB intake, expanding the narrow approach of current food policies in Mexico. Secondly, this thesis provides a rich description of adolescents' SSB intake in the home and school environment respectively in Mexico, an issue no previous research has explored. Furthermore, it presents the first exploration of adolescents' perceptions of the SSB taxation. Despite recent evaluations of the current SSB taxation (Colchero et al., 2017a, 2016), no study has investigated the perceptions and awareness of this tax, as well as the perceptions around the effect of tax on SSB intake and substitution patterns. Focusing on adolescents might have important implications, as this population group has the highest intake of SSBs and are susceptible to marketing. Another strength of this thesis is the use of a nationally representative data set, which permitted the classification of SSB consumers at a national level by using more robust individual-centred approach methods, namely mixture models approach (Wang and Wang, 2012). The use of non-linear models and regression mixture models (RMM) in this thesis presents a more adequate alternative to skewed models and over-dispersed data that are common in diet and physical activity research.

9.7.2 Overall limitations

9.7.2.1 Limitation of the study design

As mentioned previously (sections 3.4.1 and 4.41), the cross-sectional design of Study 1 and 2, not only hinders any causality inference but also prevents capturing any variation in the intake due to seasonal effects and taxation policies. Moreover, the sampling strategies used for Study 2, where the lack of randomisation and stratification of schools could have led to selection bias, prevent any generalisation of the findings to state and national level. In addition, there was a notably low recruitment rate from universities, which did not allow to properly assess potential differences in the factors measured due to transition from high school to higher education. Purposive sampling was also used to recruit participants for the qualitative interviews. Nonetheless the majority of participants were high school students and from private schools, which, in turn, led to a sample of adolescents from a medium to high SES. Mexico is a large and diverse country where not only physical but also cultural differences have been acknowledged across regions and therefore a limitation is that the data collection was only carried out in one city setting. Although the findings provided insightful information about SSB intake, it is not known whether results are generalisable to adolescents residing in rural areas, in the south of Mexico, or in larger and developed cities like Mexico City.

9.7.2.2 Limitations of the measurements

All data analysed in this thesis resulted from self-reports, including SSB intake, as well as individual, social and environmental factors. The main risk with self-reported data or memory-base methods is the potential for recall bias resulting in underreporting or over-reporting (Naska et al., 2017). Although participants were assured that their answers were to be anonymised and never shown to other classmates/peers, there is a chance of social desirability bias, which might have made participants underreport or overreport their intake of SSBs or other behaviours during the assessments.

In term of dietary assessment, it is important to consider that self-reported diet measures used in this thesis (SFFQ and BEVQ) are considered error-prone as they ask individuals to recall their food intake in retrospective relying on individuals' memory. This can be a source of error and often results in underreporting of dietary intake (Archer et al., 2018; Dhurandhar et al., 2015; Subar et al., 2015). A debate has arisen regarding the use of self-reported dietary measures, particularly on whether they should stop being used to assess diet, energy intake and to examine diet-disease association (Archer et al., 2018; Freedman et al., 2014). On the other hand, it has been argue that self-report tools should continue to be used mainly because there is not a "gold standard" for diet assessment (Willet, 2013).Thus, until a more objective measure is widely available to assess diet, especially in population based studies, self-reported tools are shown to be useful in providing an estimation of dietary trends in the population (Martín-Calvo and Martínez-González, 2018). Nonetheless, it is important to carry adequate validation of this tools in order to understand the source of error and treat findings accordingly.

Even though, validity studies of self-report instruments (like FFQs, 24HR) have been carried in different countries, many of these studies (including those used to validate the SFFQ used in the ENSANUT 2012) were validated against other self-reported dietary assessment (i.e. FFQ vs. repeated 24HR) (Freedman et al., 2014; Steinemann et al., 2017). This type of validation has been acknowledged to be subject to the correlated error problem. This occurs when comparing two self-report tool as both are subject to the same random and systematic errors (i.e. error from 24HR is similar to the error from the FFQ other as both measures rely on the memory of individuals) (Freedman et al., 2017; Yokota et al., 2010). Nonetheless, more recent literature has focus on the validation of self-reported assessment against more objective tools such as biomarkers. It has been suggested that biomarkers are the optimal approach to provide true intake of on dietary components and are better referent in validation studies due to the independent in their random errors (Rollo et al., 2016; Yokota et al., 2010). Finding from a pooled analysis from five validation studies dietary self-reported tool (FFQ and 24HR) using recovery biomarkers, showed correlations between energy intake from biomarker (doubly labelled water) and FFQ (r=0.21) and single 24HR (r=0.26) and the average of three 24HR (r=0.31) (Freedman et al., 2014). Despite this correlation among methods, the correlation coefficient were normally below 0.50 and thus under threshold that is considered acceptable in validation studies using biomarker which is (r ~0.50 to 0.70) (Davy et al., 2011) . Also, it was found that the average rate of underreporting energy intake across studies was higher for FFQs (28%) than for a single 24 HR (15%) (Freedman et al., 2014), suggesting that in terms of energy intake FFQ have higher rate of under reporting than 24HR. This has been observed in other studies (Neuhouser et al., 2008; Subar et al., 2003) which has led to the conclusion that FFQs are not adequate to measure energy intake (Freedman et al., 2014). Nonetheless, the main outcome of this thesis was on SSBs intake not energy intake, therefore was of importance to evaluate the research conducted to validated FFQs and 24HRs in relation to biomarkers in terms of SSB. As discussed in Chapter 4, $\delta^{13}C$ value has been used as a biomarker for true intake of SSBs, showing low to moderate correlation with the SSB intake determined by the BEVQ in adults (Davy et al., 2011; Hedrick et al., 2015). A recent study by MacDougall et al. (2018) validated the biomarker $\delta^{13}C$ value against repeated 24HR (4 recalls) in children and adolescents showing a positive correlations between the two methods (SSB ml/d: r=0.35, p<0.001 and SSB kcal/day: r=0.35, p<0.001). The correlation coefficients were consisted with previous validation studies which can indicate that for assessing intake of SSB only self-reported can be useful but always consider measurement errors and treat result accordingly.

Although biomarkers are objective tool to asses dietary intake, they cannot yet fully replace self-report tools currently there is no biomarkers available for all dietary food components, thus use of biomarker is limited to specific food nutrients and to energy intake (Freedman et al., 2017; Martín-Calvo and Martínez-González, 2018). It has also been acknowledged that there are cost limitation of assessing dietary intake using biomarkers, especially in big scale studies (Freedman et al., 2014). Therefore, for the time being, biomarkers can complement and aid validation of self-reported tools (Rollo et al., 2016), but not completely replace the use of self-reported dietary assessment (Martín-Calvo and Martínez-González, 2018).

The next section (9.8) discusses in more detail how this limitation can be overcome in future research. Finally, as discussed in section 4.4.1, the assessment of psychosocial constructs was limited by the omission of items that measured specific TPB constructs (Eisinga et al., 2013).

9.8 Implication for future research

This thesis has several implications for future research around the intake of SSBs in Mexico. Firstly, more research is needed to validate the findings presented in this thesis. For instance, in order to validate the results from Chapter 3, regression mixture models could be applied to the dietary data collected through 24-hour recalls and to assess whether differences exist between different profiles of SSB consumers. Additionally, the same analysis could be conducted to the more recent dietary data collected by the ENSANUT-2016, when they become publicly available, to assess whether any changes in SSB consumer profiles have taken place following taxation. Ideally, this should be carried out using longitudinal data, however, there is a lack of such national representative data in Mexico. A few prospective studies have recently been published (Cantoral et al., 2015; Caravali-Meza et al., 2016; Stern et al., 2017) however, their follow-up period is short (1 to 5 years) and does not account for transitional stages (i.e. childhood to adolescence or adolescence to adulthood). With appropriate longitudinal data it would be possible to assess changes in the profile of SSB consumers over time, for example from childhood/adolescence to adulthood, by using longitudinal methods such as growth mixture models or latent transition models (Wang and Wang, 2012).

All dietary and environmental data used in this thesis and in research in Mexico relies on self-reported measures. In terms of dietary assessment, FFQs and 24-hour recalls have been the most used methods in national surveys, including the ENSANUT (Denova-Gutiérrez et al., 2016a), as well in smaller scale studies. In the ENSANUT-2012, both methods were used, however a limitation is that dietary data was only collected in a single time point, where only a sub-sample of 981 individuals completed a second 24 HR which is not nationally representative. This indicates that future dietary research should: 1) pursue the collection of at least three days of dietary assessment to account for day to day variance and 2) consider the use of more objective measures of diet that do not rely completely on self-reports. Recent advances in dietary assessment include the use of image-based methods, either using passive methods like automated wearable cameras or active methods like smartphones and digital cameras. This could complement traditional self-reported diet measurements (Rollo et al., 2016) by providing a more accurate measurement of diet by revealing underreported food or any misreporting errors (Gemming et al., 2015b; Gemming and Ni Mhurchu, 2016). A pitfall of this image-based method is that it can be a burden to the dietitian or trained personnel as they are the ones who are estimating portion sizes (Ashman et al., 2016) and for participants in the case of not using automated cameras as they need to remember to take the picture and write or record any accompanying messages if and when necessary (Gemming et al., 2015c). Another limitation of these methods is that image analysis alone cannot determine cooking methods, hidden ingredients or the type of dietary components, and therefore affect the accuracy (Gemming et al., 2015c). Also, the use of biomarkers such as $\delta^{13}C$ value to validate self-reported beverage intake could provide new insight for the improvement of dietary assessment in Mexico. Nonetheless, none of these novel methods have yet been examined in Mexico, which represents a practical opportunity for future research.

In terms of food environment measurements, a similar situation as with diet has been identified. Self-reported measures can limit the evaluation of the food environment surrounding Mexican youth, which can have an impact on policy making. The research presented in this thesis used conservative self-reported measures of availability of SSBs at home and school (Chapter 4), which was supported by further qualitative research exploring the home and school contexts in depth and presenting them with an initial description of the local food environments (Chapter 6 and 7). Combined, this information provides some evidence that food environments can influence the intake of SSBs among a sample of Mexican adolescents. Nonetheless, adolescents' perceptions of the food environment should be accompanied by objective methods that accurately measure the different components of food environments without relying only on self-reports (Caspi et al., 2012). For instance, results from the qualitative study suggested that what is sold within food outlets contributes to the intake of SSBs (Chapter 7), however no research in Mexico has attempted to measure objectively SSBs within different food outlets. Store audits are considered an objective method to assess food availability, level of variety, and the use of shelf space in different food outlets. There are validated observational measures in the form of checklists that can assist store audits. Among the most used tools are the Nutrition Environments Measure Survey (NEMS) for stores, restaurants and vending machines (Glanz et al., 2007; Saelens et al., 2007) and the USDA's Thrifty Food Plan (Carlson et al., 2007). However, these tools will need to be adapted to the Mexican food environment and appropriate validation studies would need to be conducted before their use.

The density and distance to food outlets, especially to a minimarket chain called Oxxo, was brought up by participants during the interviews, indicating the influence of spatial accessibility of SSBs. Nonetheless, no study so far has measured this objectively in association with SSB intake or any other dietary behaviour or health outcome in Mexico, and this therefore represents a viable opportunity for future research. Among the most used methods to measure the availability and accessibility of food outlets is GIS-based measures (Charreire et al., 2010), and more recently global positioning systems (GPS) (Cetateanu and Jones, 2016). Similar to diet assessment, wearable cameras can be used to measure food and its social environments, which can be useful for future SSB research as it would be possible to not only measure the physical location of adolescents but also their exposure to marketing (Chambers et al., 2017; Signal et al., 2017) and social interactions when they are drinking SSBs (Gemming et al., 2015a). Therefore, as suggested by the research in this thesis and by Caspi et al. (2012), given that the food environment has divergent features it is important that forthcoming research combines multiple environment techniques measures like geospatial, store audit and image based measures. More importantly, assessment of the food environment should not be limited to community but also be expanded to homes, schools and worksites (Lytle and Sokol, 2017). It is clear that more research is needed in Mexico with regards to the food environment and its association with SSB intake or any other health or dietary outcome, however for these studies to occur, better data is needed that considers information from small areas (municipalities, neighbourhoods) and preferably georeferenced areas. For example, although the ENSANUT is a representative survey at the national and state levels, it is not representative at the municipal level, which may limit any geospatial analysis in relation to the diet and nutritional status of the Mexican population.

Finally, this thesis mainly focuses on adolescents' intake of SSBs, but findings from Study 1 point out that adults are also heavy consumers of SSBs. Therefore, a similar socio-ecological research should be adapted and conducted for the adult Mexican population to assess to what extent individual, social and environmental factors also apply to adults and to develop interventions to reduce SSBs that are tailored to adults' activities and social contexts.

9.9 Conclusions

The aim of this thesis was to increase understandings of what the socioecological factors are that determine the intake of SSBs in Mexico with emphasis upon the age group with the highest intake: adolescents. Findings demonstrated that multi-level factors such as taste, habit, family and peers, access and availability in different settings are promoting adolescents' intake of SSBs. Also, the research presented in this thesis permitted analysis of the current status of food polices, including school nutrition policies and the SSB tax, and identified potential ways to ameliorate their efficacy.

The next step should be the development of a multi-level intervention to reduce the intake of SSBs among Mexican adolescents. The primary outcome this multi-level intervention could be to promote a substitution of SSB with water. Based on the research presented throughout this thesis a future multi-level intervention should act simultaneously in the different level of influence relevant to adolescents. These being the individual/personal, environmental (home and school), policy and food environments. Figure 9.3 shows the suggested component of this multi-level intervention directed to adolescents in Mexico. The idea is that each component of each "bubble" complement and reinforce each other and work together to promote the replacement of SSBs. Considering that the research presented in this thesis was carried in city in the state of Sonora is sensible to pilot multi-level intervention in this area first before aiming for a wider intervention.

Figure 9.3 Components of multi-level intervention to promote the substitution of SSB with water and reduce intake of SSBs

However as outlined previously, these components need to subject of more formative work before the development of a robust and effective intervention. It is hoped that this thesis will support this research by providing preliminary evidence that addresses the importance of using a more comprehensive approach to addressing the intake of SSB among Mexican adolescents.

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Appendices

Appendix 1: Ethical approval

School for Policy Studies

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18 April 2016

Ana Ortega Avila
School for Policy Studies
University of Bristol
8 Priory Road

Dear Ana

Title: Beverage intake and social media use (SPS.REC14-15.A16)

The School for Policy Studies Research Ethics Committee has reviewed your application with regard to this project and we have received your responses to our requests for clarification. As such I am happy to provide REC approval for this project.

Please do not hesitate to contact me if you have any queries.

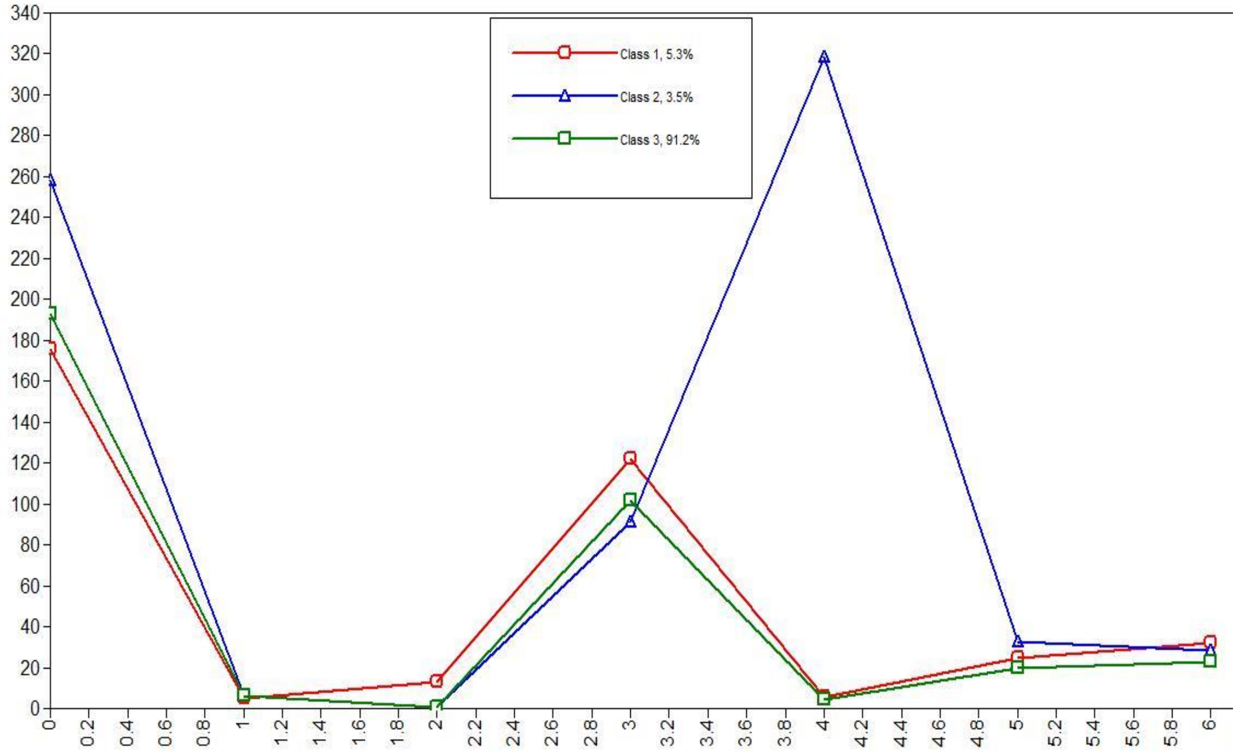
Yours sincerely

(on behalf of)

Beth Tarleton
Chair of the SPS Research Ethics Committee

Appendix 2: Latent profile analysis results

Latent profile analysis (LPA) using sugar-sweetened beverage data from the ENSANUT 2012



Appendix 3: Regression Mixture Model results comparison.

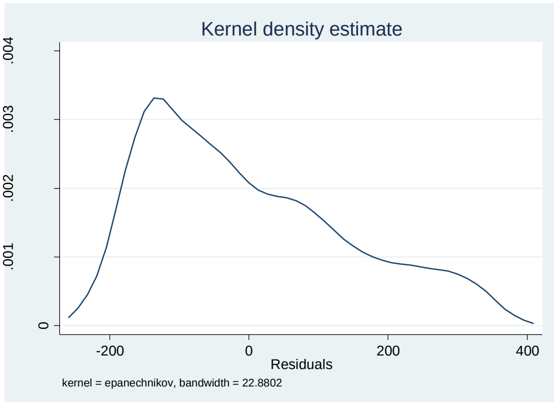
Class	Class 1				Class 2				Class 3			
Proportion	75%				18%				7%			
Intercept	186.7				719.5				1378			
Parameter	Odd logit	OR	SE	P value	Odd logit	OR	SE	P value	Odd logit	OR	SE	P value
Multinomial logistic regression (1-step approach)												
C on												
Gender	ref	ref	ref	ref	-0.50	0.61	0.19	0.01	-0.30	0.74	0.28	0.28
Central	ref	ref	ref	ref	0.20	1.22	0.18	0.27	0.22	1.25	0.24	0.35
Mexico City	ref	ref	ref	ref	0.21	1.24	0.24	0.36	0.89	2.43	0.43	0.04
South	ref	ref	ref	ref	0.25	1.29	0.16	0.12	0.05	1.05	0.25	0.85
Med SES	ref	ref	ref	ref	0.44	1.54	0.15	0.003	0.21	1.23	0.22	0.35
High SES	ref	ref	ref	ref	0.56	1.76	0.16	<0.001	0.23	1.26	0.24	0.33
Adolescents	ref	ref	ref	ref	1.03	2.79	0.27	<0.001	2.78	16.09	0.60	<0.001
Adults	ref	ref	ref	ref	0.96	2.60	0.30	0.001	2.59	13.28	0.59	<0.001
Gender	0.50	1.64	0.19	0.01	ref	ref	ref	ref	0.20	1.23	0.41	0.62
Central	-0.20	0.82	0.18	0.27	ref	ref	ref	ref	0.03	1.03	0.31	0.94
Mexico City	-0.21	0.81	0.24	0.36	ref	ref	ref	ref	0.68	1.97	0.43	0.11
South	-0.25	0.78	0.16	0.12	ref	ref	ref	ref	-0.21	0.81	0.30	0.48
Med SES	-0.44	0.65	0.15	0.003	ref	ref	ref	ref	-0.23	0.80	0.25	0.36
High SES	-0.56	0.57	0.16	<0.001	ref	ref	ref	ref	-0.34	0.72	0.27	0.22
Adolescents	-1.03	0.36	0.27	<0.001	ref	ref	ref	ref	1.75	5.76	0.58	0.002
Adults	-0.96	0.38	0.30	0.001	ref	ref	ref	ref	1.63	5.10	0.53	0.002
Gender	0.30	1.34	0.28	0.28	-0.20	0.82	0.41	0.62	ref	ref	ref	ref
Central	-0.22	0.80	0.24	0.35	-0.03	0.98	0.31	0.94	ref	ref	ref	ref
Mexico City	-0.89	0.41	0.43	0.04	-0.68	0.51	0.43	0.11	ref	ref	ref	ref
South	-0.05	0.95	0.25	0.85	0.21	1.23	0.30	0.48	ref	ref	ref	ref
Med SES	-0.21	0.81	0.22	0.35	0.23	1.25	0.25	0.36	ref	ref	ref	ref

High SES	-0.23	0.80	0.24	0.33	0.34	1.40	0.27	0.22	ref	ref	ref	ref
Adolescents	-2.78	0.06	0.60	<0.001	-1.75	0.17	0.58	0.002	ref	ref	ref	ref
Adults	-2.59	0.08	0.59	<0.001	-1.63	0.20	0.53	0.002	ref	ref	ref	ref
Multinomial logistic regression (3-step approach)												
C on												
Gender	ref	ref	ref	ref	-0.42	0.66	0.13	0.00	-0.34	0.71	0.20	0.10
Central	ref	ref	ref	ref	0.14	1.15	0.18	0.45	0.17	1.18	0.22	0.45
Mexico City	ref	ref	ref	ref	0.22	1.25	0.24	0.35	0.85	2.33	0.31	0.01
South	ref	ref	ref	ref	0.21	1.23	0.17	0.22	0.05	1.05	0.24	0.84
Med SES	ref	ref	ref	ref	0.40	1.49	0.16	0.01	0.24	1.27	0.22	0.28
High SES	ref	ref	ref	ref	0.58	1.79	0.17	<0.001	0.25	1.28	0.23	0.29
Adolescents	ref	ref	ref	ref	0.83	2.28	0.16	<0.001	2.74	15.44	0.50	<0.001
Adults	ref	ref	ref	ref	0.85	1.17	0.16	<0.001	2.55	12.81	0.46	<0.001
Gender	0.42	1.52	0.13	0.00	ref	ref	ref	ref	0.08	1.08	0.24	0.73
Central	-0.137	0.87	0.18	0.45	ref	ref	ref	ref	0.03	1.03	0.28	0.92
Mexico City	-0.221	0.80	0.24	0.35	ref	ref	ref	ref	0.63	1.87	0.36	0.08
South	-0.205	0.81	0.17	0.22	ref	ref	ref	ref	-0.16	0.86	0.29	0.59
Med SES	-0.399	0.67	0.16	0.01	ref	ref	ref	ref	-0.16	0.85	0.26	0.54
High SES	-0.581	0.56	0.17	<0.001	ref	ref	ref	ref	-0.34	0.72	0.28	0.22
Adolescents	-0.826	0.44	0.16	<0.001	ref	ref	ref	ref	1.91	6.76	0.56	<0.001
Adults	-0.852	0.43	0.16	<0.001	ref	ref	ref	ref	1.70	5.47	0.50	<0.001
Gender	0.34	1.40	0.20	0.10	-0.08	0.92	0.24	0.73	ref	ref	ref	ref
Central	-0.17	0.85	0.22	0.45	-0.03	0.97	0.28	0.92	ref	ref	ref	ref
Mexico City	-0.85	0.43	0.31	0.01	-0.63	0.54	0.36	0.08	ref	ref	ref	ref
South	-0.05	0.95	0.24	0.84	0.16	1.17	0.29	0.59	ref	ref	ref	ref
Med SES	-0.24	0.79	0.22	0.28	0.16	1.17	0.26	0.54	ref	ref	ref	ref
High SES	-0.25	0.78	0.23	0.29	0.34	1.40	0.28	0.22	ref	ref	ref	ref
Adolescents	-2.73	0.07	0.50	<0.001	-1.91	0.15	0.56	0.00	ref	ref	ref	ref
Adults	-2.55	0.08	0.46	<0.001	-1.71	0.18	0.50	0.00	ref	ref	ref	ref

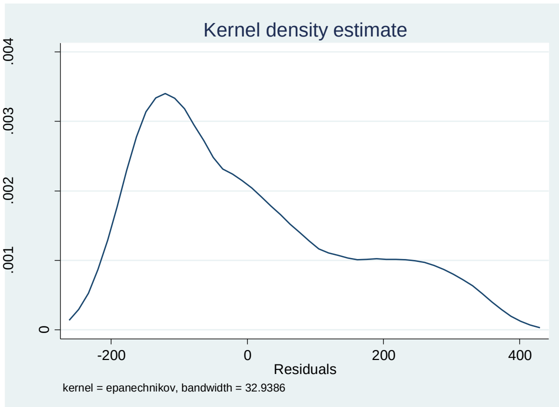
Appendix 4: Regression Mixture Model residual examination

Residual distribution of each of the 4 classes in the in the 4-class regression mixture model estimated using 3-step approach with equal variance.

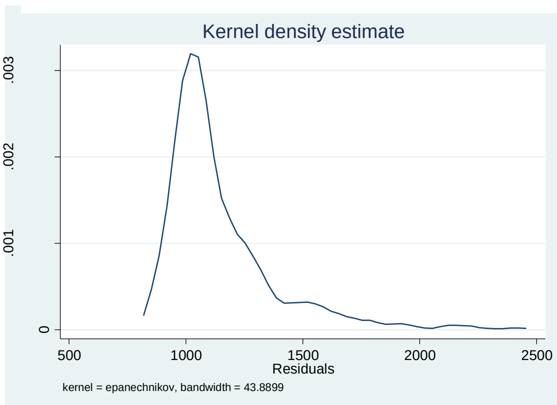
Residual distribution of class 1



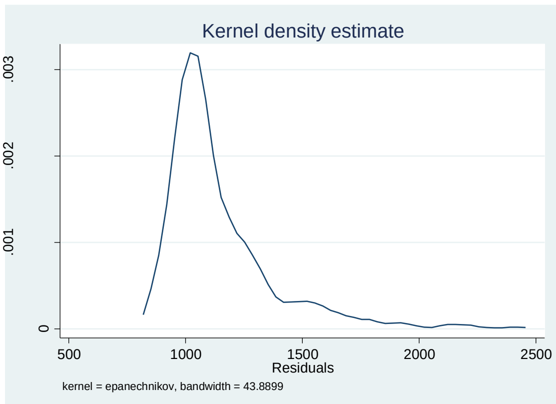
Residual distribution of class 2



Residual distribution of class 3



Residual distribution of class 4



Appendix 5: Multinomial logistic regression results

Three-class multinomial logistic regression with the 3-step approach using heavy SSB drinkers as reference

Class **Proportion**	Class1 75%					Class 2 18%				
Parameters	OR	SE	95% CI		P value	OR	SE	95% CI		P value
Intercept	186.7					719.5				
C on										
Gender	1.4	1.22	0.95	2.08	0.1	0.92	1.27	0.58	1.48	0.73
Central	0.85	1.25	0.55	1.30	0.45	0.97	1.32	0.56	1.68	0.92
Mexico City	0.43	1.36	0.23	0.78	0.01	0.54	1.43	0.26	1.08	0.08
South	0.95	1.27	0.59	1.52	0.84	1.17	1.34	0.66	2.07	0.59
Med SES	0.79	1.25	0.51	1.21	0.28	1.17	1.30	0.70	1.95	0.54
High SES	0.78	1.26	0.50	1.22	0.29	1.4	1.32	0.81	2.43	0.22
Adolescents	0.07	1.65	0.02	0.17	<0.001	0.15	1.75	0.05	0.44	<0.001
Adults	0.08	1.58	0.03	0.19	<0.001	0.18	1.65	0.07	0.48	<0.001

Three-class multinomial logistic regression with the 3-step approach using moderate SSB drinkers as reference

Class **Proportion**	Class 1 75%					Class 3 7%				
Parameter	OR	SE	95%CI		P value	OR	SE	95% CI		P value
Total SSBs Intercept	186.7					1378				
C on										
Gender	1.52	1.14	1.18	1.96	0	1.08	0.24	0.68	1.73	0.73
Central	0.87	1.20	0.61	1.24	0.45	1.03	0.28	0.60	1.78	0.92
Mexico City	0.8	1.27	0.50	1.28	0.35	1.87	0.36	0.93	3.80	0.08
South	0.81	1.19	0.58	1.14	0.22	0.86	0.29	0.48	1.50	0.59
Med SES	0.67	1.17	0.49	0.92	0.01	0.85	0.26	0.51	1.42	0.54
High SES	0.56	1.19	0.40	0.78	<0.001	0.72	0.28	0.41	1.23	0.22
Adolescents	0.44	1.17	0.32	0.60	<0.001	6.76	0.56	2.25	20.24	<0.001
Adults	0.43	1.17	0.31	0.58	<0.001	5.47	0.5	2.05	14.59	<0.001

Adjusted Regression mixture model

Five models were estimated, and the model fit statistics can be found in Table 26. Even though all models showed good entropy (i.e. good class classification), the 5-class model had the lowest BIC and SABIC. It is well known in the mixture model literature that the statistics of these models tend to favour models with more classes even though, in some cases, the models split a meaningful class into two unmeaningful classes. One of the classes in the 5-class model was very small with only 33 individuals (less than 1% of the sample), thus by examining the other classes it was assumed that the 5-class model was dividing one of the classes in two. Then, the 4-class solution was considered, however the same pattern was observed where only 84 individuals (1%) were classified in this class but classes were meaningful and therefore was kept for further inspection.

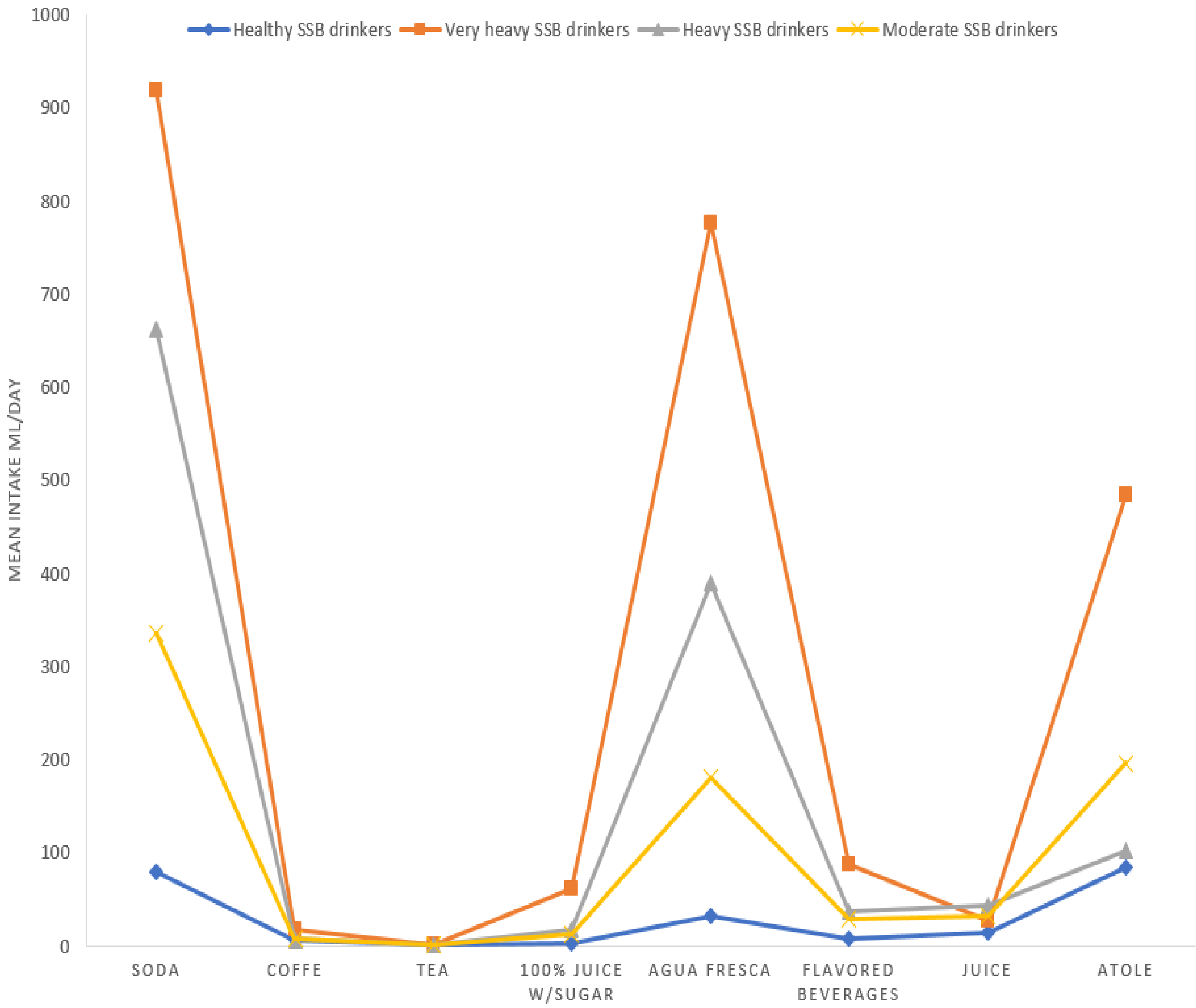
Table 3 Model fit statistics of the adjusted regression mixture model

Model	BIC	SABIC	Entropy
2-class-RMM	112615	112602	0.92
3-class-RMM	111869	111850	0.92
4-class-RMM	110843	110818	0.90
5-class-FMM	110395	110363	0.91

BIC= Bayesian information criteria; SABIC= Sample-size adjusted criterion

Four classes were defined: i) Class 1, labelled “healthy SSB drinkers”, as this group showed a relative low intake of SSBs compared to the other classes with an intake of 154 ml/day. This group was the largest with 68% of the sample; ii) Class 2, the “extreme SSB drinkers”, represented the smallest group with 1% of the sample and the highest intake of SSBs with a mean intake of 1968 ml/d of SSBs a day and; iii) Class 3, the “heavy SSB drinkers” (7% of the sample), with a mean SSB intake of 1173 ml/d; iv) Class 4, the “moderate SSB drinkers” represented the 21% of the sample and consume an average of 609 ml/d of SSB.

Intake patterns were similar across classes (Figure 3.2), where soda was the most consumed beverage by individuals in all four classes (C1=80ml/d; C2= 919ml/d; C3=662 ml/d; and C4=336ml). This was followed by *aguas frescas* (C1=31ml/d; C2=777ml/d; C3=389ml/day; and 180 ml/d). Among the less consumed SSBs were sweetened coffee, tea and sweetened 100% fruit juice, for which average intake was less than 10 ml/day, with the exception of individuals of Class 2 (extreme SSB drinkers), who consumed on average 61 ml/day of sweetened 100% fruit juice.



Sociodemographic profile of healthy SSB drinkers

Females showed higher odds compared to males to be in the "healthy SSB drinkers" than in the 'heavy SSB drinkers' class (OR=1.69; 95% CI=1.14,3.15; p=0.008). However, when compared to the 'extreme SSB drinkers' and the "moderate SSB drinkers', both male and females showed equal odds to be in the healthy SSB drinkers' class. Adolescents and adults were less likely (please see table 27 as odd ratios are too large to be reported here) compared to children to be in the “healthy SSB drinkers” than in the “extreme SSB drinkers” and “heavy SSB drinkers’ class. Individuals in the low SES tertile comported to those in the medium and high SES, were more likely to be in the ‘healthy SSB drinkers’ class than in the other three classes. All regions presented equal odds of being in the ‘healthy SSB intake’ class compared to the moderate SSB drinkers. However, those residing in the north region compared to the central region and Mexico City, were more likely to be in in the ‘Healthy SSB drinkers’ class than in the ‘heavy SSB drinkers’ and ‘very heavy SSB drinkers.

Sociodemographic profile of moderate SSB consumers

As shown in Table 27 when compared to the healthy SSBs drinkers, both male and females had equal odds to be in the moderate SSB drinkers’ class compared to the other three classes. When compared to the ‘heavy SSB drinkers’ and the “extreme SSB drinkers” classes, children were less likely to be in the moderate consumer class than adolescents and adults. However, when compared with the ‘healthy SSB drinkers’ all age groups showed equal odds to be in the moderate class (Table 27). Individuals in the medium and high SES tertile, relative to individuals in the low SES tertile, were more likely to be in the moderate SSB consumer class than in the healthy SSB consumer group. However, when compared to the high intake classes, all SES tertiles showed equal odds of being in the moderate intake class. Likewise, no regional differences were observed for the moderate SSB drinkers’ group when compared to the healthy and heavy SSB drinkers, however when compared to the extreme SSB drinkers the residents of Mexico City were less likely to be in the moderate SSB drinkers.

9.9.1 Sociodemographic profile of heavy SSB drinkers

Females were less likely to be in this class in the high intake group compared to the healthy SSB drinkers, however, no differences in gender when compared to the moderate and extreme SSB drinkers. When age groups were compared to the lower intake group, adolescents were nearly five times more likely to be classified in “heavy SSB drinkers” class than children and adults were almost three times than children (Table 27). Odds decreased slightly when compared to the “moderate SSB drinkers” but remained significant. Individuals residing in Mexico City relative to residents from the northern region, showed to be two times more likely to be in the high consumer group compared to the healthy SSB drinker class. Nonetheless, no evidence was found to support differences in any of the regions when comparing the moderate SSB drinkers and the heavy SSB drinkers’ classes/

Sociodemographic profile of extreme SSB drinkers

No gender differences were found in the groups, thus both male and females had equal odds to belong to this group. Adolescent compared to children showed higher odds to be in the extreme SSB drinkers’ class than in the healthy SSB drinkers. Adults showed similar odds, showing slightly higher odds than adolescents when compared to heavy and moderate consumers classes. Those with high SES relative to low and medium SES were more likely to be in this group when compared to healthy SSB drinkers. Equal odds for all tertiles was found when the reference group was heavy and moderate SSB drinkers. In term of region, those residents of Mexico City and the central region showed higher odd than those residing in the north to classified as extreme SSB drinkers.

Table 4 Adjusted Multinomial logistic regression for the 4-class model

Class	**Extreme SSB drinker**				**Heavy SSB drinker**				**Moderate SSB drinkers**			
Proportion	1%				8%				21%			
Average SSB intake per class (ml/d)	1968				1173				609			
Paramenter	OR e	SE	95% CI	P value	OR [f]	SE	95% CI	P value	OR [g]	SE	95% CI	P value
Gender [a]	1.74	1.95	[0.47,6.47]	0.41	0.59	1.22	[0.4, 0.87]	0.008	0.8	1.15	[0.61,1.05]	0.103
Central [b]	5.55	2.32	[1.07,28.7	0.04	0.99	1.25	[0.64,1.52]	0.95	1.27	1.19	[0.9,1.79]	0.182
Mexico City[b]	16.89	2.91	[2.08,137.3]	0.01	2.25	1.38	[1.2,4.2]	0.012	1.41	1.33	[0.8,2.46]	0.231
South [b]	1.64	2.74	[0.23,11.8]	0.62	1.03	1.28	[0.64,1.66]	0.909	1.26	1.21	[0.88,1.82]	0.208
Med SES [c]	5.67	3.08	[0.63,51.3]	0.12	2.57	1.28	[1.57,4.19]	<0.001	2.1	1.2	[1.47,3.02]	<0.001
High SES [c]	17.69	3.17	[1.84,169.8]	0.01	4.1	1.32	[2.37,7.09]	<0.001	2.9	1.24	[1.91,4.4]	<0.001
Adolescents [d]	119759964.3	1.9	[34027514.3, 421495643.6	<0.001	4.81	1.43	[2.38,9.72]	<0.001	1.25	1.17	[0.92,1.71]	0.146
Adults [d]	90512633.9	1.17	66147655.1, 123852264	<0.001	2.91	1.42	[1.47,5.78]	0.002	0.78	1.17	[0.57,1.07]	0.128

[a] Reference is males; [b] reference is North; [c] reference is low SES; [d] reference is children; [e] odds are for class 2: Moderated SSB drinkers vs. class1: Healthy SSB drinkers for each of the reference groups listed above; [f] odds of class 3: High SSB drinkers vs. class 1: Healthy SSB drinkers for each of the reference group listed above; [g]

Appendix 6: Schools' invitation and consent form

RECRUITMENT EMAIL TO SCHOOLS

Dear [name of school principal],

As part of a PhD project at the Centre for Exercise, Nutrition and Health Sciences in the School for Policy Studies at Bristol University we are conducting a study that is looking at beverage intake and Social media use in older adolescents in the city of Hermosillo, Mexico. We are inviting [name of school] to take part in this research study.

This project is intended to provide valuable information of older Mexican adolescent's beverage intake and social media use, with the aim of informing the design of future effective healthy eating interventions in this population. The project is being carried out by Ana Ortega, who is a PhD candidate in Health and Wellbeing at the University of Bristol. The project is supervised by Professor Russell Jago and Dr Angeliki Papadaki and has received ethical approval from the School for Policy Studies Research Ethics Committee.

Please take time to read the attached information sheet which provides details of the study procedures and feel free to contact me if you require more information. If you agree to participate, kindly sign the attached consent form and return it to me by e-mail (you can use an electronic signature), and also please provide me with the following information:

1. How many students, aged 16-19 years, does the [name of school] have?
2. How do you normally communicate news or events to students (i.e. e-mail, newsletter, other)?
3. Will you be willing to circulate an invitation to participate in the study email to all students aged 16-19 years old?

I will then send you details of how to proceed with the invitation of students to take part in the study.

If this email has not been sent to the appropriate person to deal with this, I would appreciate if you forwarded this message on to the correct person or sent me details of who it would be best for me to contact about this matter. Also, please do not hesitate to contact me if you require more information.

Thank you very much in advance for your time and I look forward to hearing from you.

Sincerely,

Ana G. Ortega Avila
Centre for Exercise Nutrition and Health Sciences
School for Policy Studies
8 Priory Road, BS8 1TZ
Bristol, England
Tel: 0117 3311094
E-mail: a.ortegaavila@bristol.ac.uk

University of BRISTOL
Centre for Exercise Nutrition and Health Sciences
School for Policy Studies
8 Priory Road
Bristol BS8 1TZ
Tel: +44 (0)117 954 6755
E-mail: a.ortegavila@bristol.ac.uk

BEVERAGE INTAKE STUDY

CONSENT FORM FOR SCHOOLS AND UNIVERSITIES

Please read each statement and write your initials in the space provided if you agree:

Initials

- I confirm that I have read and understood the information sheet. ☐
- I confirm that I have had the opportunity to ask questions about this study and if so, I have received satisfactory answers to all my questions. ☐
- I understand that participation of the [school/University] is voluntary and that we are free to withdraw from the study at any time without giving any reasons. ☐
- I understand that any files containing information about the school and its students will be made anonymous, will be treated as confidential and will be stored on password protected computers. At the end of the project, data will be stored for 10 years in appropriate storage facilities. ☐
- I agree to the University of Bristol processing this information and I understand that this information will be used only for the purposes of this study. My consent is conditional upon the University complying with its duties and obligations under the Data Protection Act. ☐
- If I agree for the [school/University] to take part in the study, I also agree to circulate an invitation to the students to complete the online survey. ☐
- I agree for the school to take part in the above study. ☐

Please sign and date here

Name of School

Name of School Representative **Signature** **Date**

Please return the signed form to a.ortegaavila@bristol.ac.uk. A copy will be sent back to you to

keep.

Appendix 7: Online survey

Online survey English version

First, we would like to ask you a few questions about yourself

1. Are you male or female? (choose one)
   Male ☐ Female ☐

2. How old are you?
   ☐ years

3. What year of school are you currently attending?
   1st year of high school ☐
   2nd year of high school ☐
   3rd year of high school ☐
   First year of university ☐
   Not applicable ☐

4. Do you live with you parents/ family?
   Yes ☐ No ☐ other (please specify) ☐

5. What is the last degree your parent(s)/guardian completed?
   Primary school ☐ Technical high school ☐
   Secondary school ☐ Teachers' college ☐
   Technical secondary school ☐ Bachelor's degree ☐
   High School ☐ Postgraduate degree ☐

6. In your <u>current</u> house you have: (chose on or more items)
   T.V. ☐ Electrical or gas stove ☐
   Washing machine ☐ Computer ☐
   Own car ☐ Internet service ☐
   Refrigerator ☐ Pay TV services ☐

7. Please report your weigh: ☐ kg

8. Please report your height: ☐ metres

The following questions are about the different kinds of beverages you drank <u>in the past month.</u>

Please indicate your response for each beverage type by clicking the circle for "how often" and "how much each time"

1. Indicate how often you drank the following beverages, for example, if you drank 5 glasses of water per week, mark 4-6 times per week.

2. Indicate the approximate number of beverages you drank each time, for example, if you drank 1 cup of water each time, mark 1 cup under "how much each time"

3. Do not count beverage used in cooking or other preparation, such as milk in cereal

4. Count milk added to coffee in the *coffee with mil/cream beverage* category NOT in the *milk categories*.

	HOW OFTEN (MARK ONE)							HOW MUCH EACH TIME (MARK ONE)				
Type of beverage	**Never or less than 1 Time per week (go to the next beverage)**	**1 time per week**	**2-3 times per week**	**4-6 times per week**	**1 time per day**	**2 times per day**	**3 or more times per day**	**Less than 180 mL (3/4 cup)**	**230 mL (1 cup)**	**340 mL (1 1/2 cups)**	**450 mL (2 cups)**	**More than 568 mL (2 1/2 cups)**
Water	O	O	O	O	O	O	O	O	O	O	O	O
100% Fruit Juice	O	O	O	O	O	O	O	O	O	O	O	O
Sweetened juice beverages/drinks (Jumex, del Valle, frutsi, bonafina)	O	O	O	O	O	O	O	O	O	O	O	O
Whole milk	O	O	O	O	O	O	O	O	O	O	O	O
Reduce Fat milk (2%)	O	O	O	O	O	O	O	O	O	O	O	O
Low fat/ Fat free milk Skim, 1%)	O	O	O	O	O	O	O	O	O	O	O	O
Regular Soft Drinks	O	O	O	O	O	O	O	O	O	O	O	O
Diet Soft drinks and other artificially sweetened drinks	O	O	O	O	O	O	O	O	O	O	O	O
Sweetened Fruit waters (Horchata, Lemonade, Jamaica)	O	O	O	O	O	O	O	O	O	O	O	O
Sweetened Iced teas	O	O	O	O	O	O	O	O	O	O	O	O
Tea or Coffee, with sugar and /or cream	O O	O O	O O	O O	O O	O O	O O	O O	O O	O O	O O	O O
Tea or Coffee, black, with or/without artificial sweetener (no cream or sugar)	O	O	O	O	O	O	O	O	O	O	O	O
Beer and Coolers	O	O	O	O	O	O	O	O	O	O	O	O
Hard Liquor (Tequila, Rum, Vodka, etc.)	O	O	O	O	O	O	O	O	O	O	O	O
Wine (red or white)	O	O	O	O	O	O	O	O	O	O	O	O
Energy & Sports Drinks (Red Bull, Rockstar, Gatorade, Powerade, etc.)	O	O	O	O	O	O	O	O	O	O	O	O
Other: ___________	O	O	O	O	O	O	O	O	O	O	O	O

The following questions are about your consumption of sugar-sweetened beverages; which are beverages that contain added sugars, such as regular soft drinks, sweetened juices, aguas frescas, iced teas, coffee with sugar and energy and sports drinks

On a scale from 0 to 10 how tasty do you find the following sugar-sweetened beverages? **(0= not tasty at all; 10 = very tasty)**

SUGAR SWEETEND BEVERAGE	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Regular soft drinks	O	O	O	O	O	O	O	O	O	O	O
Sweetened juice and beverages (Jumex, del Valle, boing)	O	O	O	O	O	O	O	O	O	O	O
Sweetened Fruit Waters (Horchata, Lemonade, Jamaica)	O	O	O	O	O	O	O	O	O	O	O
Sweetened Iced teas	O	O	O	O	O	O	O	O	O	O	O
Coffee with sugar	O	O	O	O	O	O	O	O	O	O	O
Energy & Sports Drinks (Red Bull, Rockstar, Gatorade, Powerade, etc.)	O	O	O	O	O	O	O	O	O	O	O

	Never	Seldom	Sometimes	Almost always	Always
Are there sugar-sugar sweetened beverages available at home	O	O	O	O	O

	Never	Less than once a week	Once a week	Everyday
How often are sugar-sweetened beverages available in your home?	O	O	O	O

Which of the following beverages are available from **vending machines** in your [school/university]?

	Yes	**No**
Regular soft drinks	O	O
Diet Soft drinks	O	O
Sweetened juice and beverages (Jumex, del Valle, boing)	O	O
Energy drinks (Red Bull, Rockstar,etc.)	O	O
Sports Drinks (Gatorade, Powerade, etc.)	O	O
Sweetened Ice teas	O	O
Aguas frescas (Horchata, Lemonade, Jamaica)	O	O
Coffee with sugar	O	O

Which of the following beverages are available in your [school/university] **canteen** counter?

	Yes	No
Regular soft drinks		
Diet Soft drinks		
Sweetened juice and beverages (Jumex, del Valle, boing)		
Energy drinks (Red Bull, Rockstar,etc.)		
Sports Drinks (Gatorade, Powerade, etc.)		
Sweetened Ice teas		
Aguas frescas (Horchata, Lemonade, Jamaica)		
Coffee with sugar		

	Strongly disagree	Disagree	No opinion	Agree	Strongly agree
I think it is good to drink a lot of sugar-sweetened beverages					
I think it is pleasant to drink a lot of sugar-sweetened beverages					
Sugar-sweetened beverages are well suited as a thirst-quencher					
Sugar-sweetened beverages are good for my health					
Sugar-sweetened beverages are well suited at meals					

	Very Bad	Bad	No opinion	Good	Very Good
When you think about drinking sugar-sweetened beverages daily, how do you feel?					
I believe that consuming a limited amount of sugar-sweetened beverages is:					

	Certainly not	No	Maybe	Yes	Certainly yes
Do you intend to drink less sugar-sweetened beverages in the upcoming year?					

	Strongly disagree	Disagree	No opinion	Agree	Strongly agree
Drinking sugar-sweetened beverages is something I do frequently					

Drinking sugar-sweetened beverages is something I do almost automatically	O	O	O	O	O
Drinking sugar-sweetened beverages is something I do without having to consciously remember	O	O	O	O	O
Drinking sugar-sweetened beverages is something that makes me feel weird if I don't do it	O	O	O	O	O
Drinking sugar-sweetened beverages is something I do without even really thinking about	O	O	O	O	O
Drinking sugar-sweetened beverages is something it would require effort not to do	O	O	O	O	O
Drinking sugar-sweetened beverages is something that belongs to my (daily, weekly, monthly) routine	O	O	O	O	O
Drinking sugar-sweetened beverages is something I start doing before I realize I'm doing it	O	O	O	O	O
Drinking sugar-sweetened beverages is something I would find hard not to do	O	O	O	O	O
Drinking sugar-sweetened beverages is something I have no need to think about doing	O	O	O	O	O
Drinking sugar-sweetened beverages is something that is typically 'me'	O	O	O	O	O
Drinking sugar-sweetened beverages is something I have been doing for a long time	O	O	O	O	O

	Very difficult	Difficult	Maybe	Easy	Very easy
Do you think is it difficult or easy to drink less sugar-sweetened beverages?	O	O	O	O	O

	Very likely to fail	Maybe I Fail	I don't know	Maybe I succeed	Very likely to succeed
Do you think you will succeed or fail in drinking less sugar-sweetened beverages if you want to?	O	O	O	O	O

	No, very little	A little	I don't know	Yes	Yes, a lot
Do your parent(s) drink sugar-sweetened beverages?	O	O	O	O	O
Do your friends drinks sugar-sweetened beverages?	O	O	O	O	O

	Never	Less than once a week	Once a week	Everyday	Several times a day
How often do your mother drink sugar-sweetened beverages?	O	O	O	O	O
How often do your father drink sugar-sweetened beverages?	O	O	O	O	O
How often do your siblings drink sugar-sweetened beverages?	O	O	O	O	O
How often do your best friend drink sugar-sweetened beverages?	O	O	O	O	O

	Certainly not	No	Maybe	Yes	Certainly yes
My parent(s) think that I should drink sugar-sweetened beverages	O	O	O	O	O
My friends think that I should drink sugar-sweetened beverages	O	O	O	O	O
Do you think your parent(s) want you to drink less sugar-sweetened beverages?	O	O	O	O	O

	No	Not very often	Maybe	Yes	Yes, a lot
Do your parent(s) encourage you to reduce sugar-sweetened beverages?	O	O	O	O	O
Do your friend(s) encourage you to reduce sugar-sweetened beverages?	O	O	O	O	O

	Not at all	Somewhat important	Very important
How important is it for you to drink the same number of sugar-sweetened beverages as your friends do?	O	O	O

In form of appreciation for completing this survey, a prize draw of **10 vouchers (100 Mexican pesos each)** will be held among participants who completed the survey. If you are interested to participate in the draw, please write you email below so we can consider you.

E-mail: ______________________________

For the purposes of this study, we will also conduct focus groups to discuss in more detail about the sources you use to obtain nutrition information, nutrition information available on the Internet and about ways to design interventions to achieve healthy eating behaviours among Mexican youth. This will help us to further understand how to deliver nutrition information. If you are interested in taking part in this future research, please enter your name and e-mail address. These contact details will be removed from the survey and will be kept only to enable us to contact you to arrange the next part of the study.

E-mail _______________________________

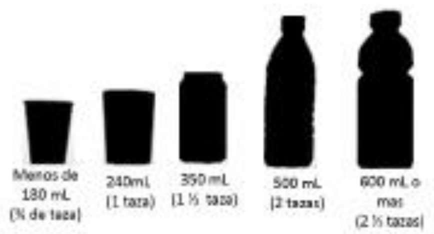
Thank you very much for completing this online survey.

Selected screenshots of the Online Survey (Spanish version) as seen by participants in Bristol Online Survey platform.

SODA REGULAR

34 ¿Con qué frecuencia?

- Nunca o menos de una vez por semana
- 1 vez a la semana
- 2-3 veces por semana
- 4-6 veces por semana
- 1 vez al día
- 2 veces al día
- 3 o más veces al día



35 ¿En qué cantidad cada vez?

- Menos de 180 mL (¾ taza)
- 240 mL (1 taza)
- 350 mL (1 ½ taza)
- 500 mL (2 tazas)
- 600 mL (2 ½ tazas) o mas

59 De las siguientes bebidas, ¿cuáles encuentras disponibles en las máquinas expendedoras en tu escuela/universidad?

	Si	No
Soda regular	☐	☐
Soda de dieta	☐	☐
Néctares de fruta o pulpa de fruta con azúcar(Jumex, del Valle, etc.)	☐	☐
Aguas de fruta o aguas frescas con azúcar (Horchata, Limonada, Jamaica etc.)	☐	☐
Té helado (Nestea, Arizona, Jaztea etc.)	☐	☐
Bebidas energéticas (Red Bull, Rockstar, Monster, etc.)	☐	☐
Bebidas deportivas (Gatorade, Powerade, etc.)	☐	☐
No hay maquina expendedora	☐	☐

60 De las siguientes bebidas, ¿cuáles encuentras disponibles en la cafeteria o tiendita de tu escuela/universidad?

	Si	No
Soda regular	☐	☐
Soda de dieta	☐	☐
Néctares de fruta o pulpa de fruta con azúcar(Jumex, del Valle)	☐	☐
Aguas de fruta o aguas frescas con azúcar (Horchata, Limonada, Jamaica etc.)	☐	☐
Té helado (Nestea, Arizona, Jaztea etc.)	☐	☐
Bebidas energéticas (Red Bull, Rockstar, Monster, etc.)	☐	☐
Bebidas deportivas (Gatorade, Powerade, etc.)	☐	☐
No hay cafetería/tiendita	☐	☐

Recuerda: Las bebidas azucaradas son aquellas que contienen azúcar añadida, como por ejemplo: **sodas regulares, jugos y aguas de sabores industrializados, té helado, café o frappes con azúcar, bebidas deportivas y bebidas energéticas.**

Elige la opción que mejor te describa.

71 Tomar bebidas azucaradas es algo que hago frecuentemente

- Totalmente en desacuerdo
- En desacuerdo
- No se
- De Acuerdo
- Totalmente de acuerdo

72 Tomar bebidas azucaradas es algo que hago casi automáticamente

- Totalmente en desacuerdo
- En desacuerdo
- No se
- De acuerdo
- Totalmente de acuerdo

73 Tomar bebidas azucaradas es algo que hago sin tener que recordar conscientemente

- Totalmente en desacuerdo
- En desacuerdo
- Sin opinion
- De acuerdo
- Totalmente de acuerdo

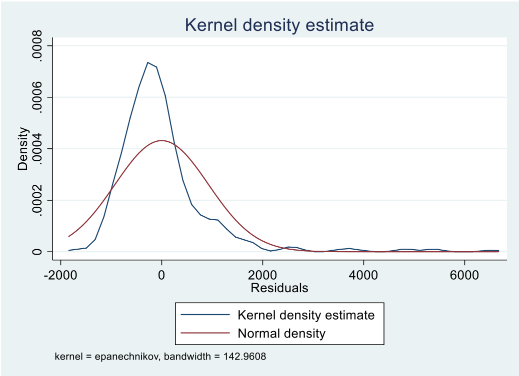
74 Si no tomo bebidas azucaradas me siento raro(a)

- Totalmente en desacuerdo
- En desacuerdo
- Sin opinion
- De acuerdo
- Totalmente de acuerdo

Appendix 8: Assumption for linear regression with non-transform variable

- ***Normality of residuals***

Normality check of residual of the linear regression

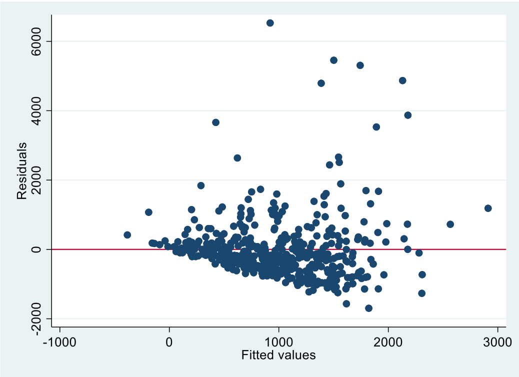


Shapiro-Wilk tests for normal data. If the p-value is significant normality of the residuals is rejected.

Variable	**W**	**V**	**z**	**P-value**
Residuals	0.761	73.34	10.277	<0.000

- ***Homoscedasticity of residuals***

Homoscedasticity of residual form linear regression by plotting residual versus fitted values. In a well fitted model, no pattern should be plotted against the fitted valued (red line)



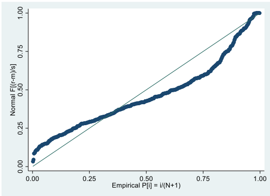
- ***Multicollinearity***

Multicollinearity check using variance inflation factor. Values greater than 10 or lower than 0.1 indicate multicollinearity

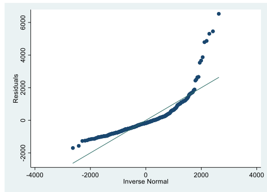
Variable	VIF	1/VIF
Gender	1.12	0.891
Age	1.40	0.716
BMI	1.10	0.913
SES	1.12	0.891
Education level	22.68	0.044
Intention	1.07	0.933
Perceived Behavioural control	1.27	0.785
Habit	1.85	0.542
Taste	1.33	0.749
Parental modelling	1.43	0.702
Peer modelling	1.40	0.714
Home availability	1.41	0.709
Home accessibility	1.57	0.637
School availability vending machines	1.29	0.778
School availability canteen	1.26	0.791
Education level vs. peer modelling	22.25	0.045
Education level vs. school availability vending machines	2.03	0.493
Education level vs. school availability canteen	6.68	0.150
Mean VIF	4.01	

- ***Linearity of residuals***

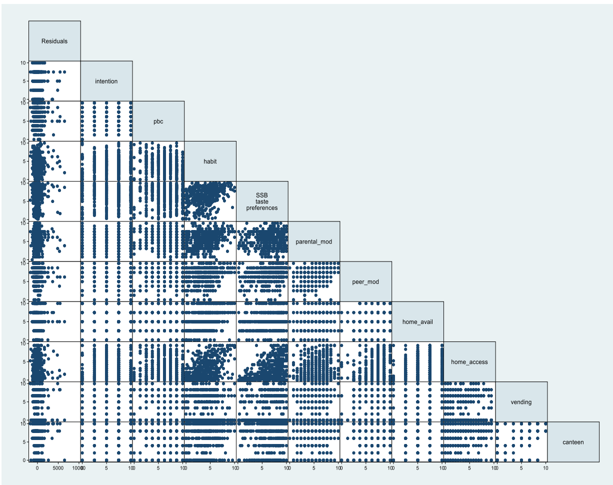
Normal probability plot



Normal quantile plot

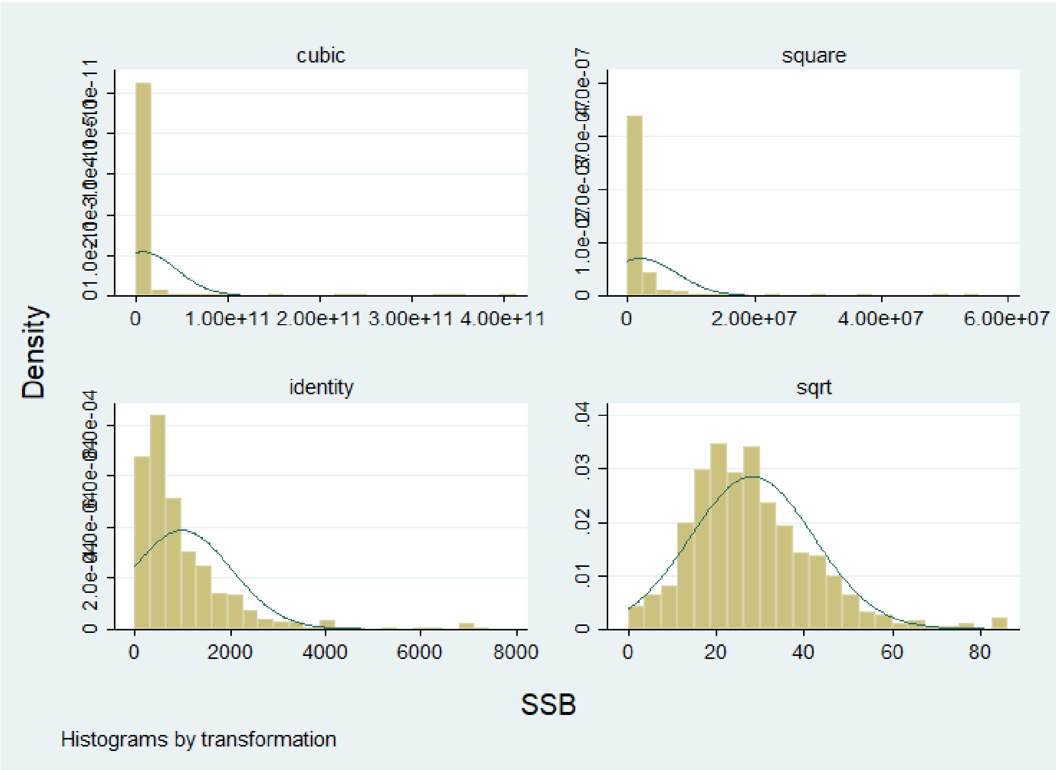


Linearity check between residuals and independent variables



Appendix 9: Variable transformation

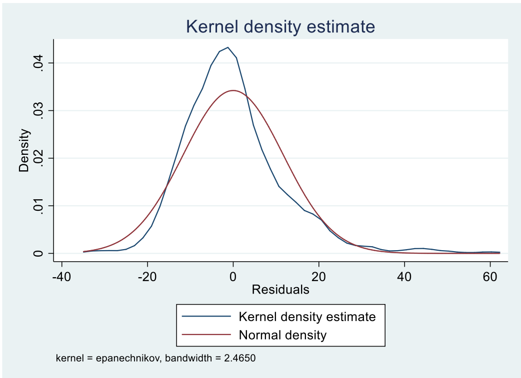
Results from the gladder command in Stata



Appendix 10: Assumption for linear regression with transformed variable

- ***Normality of residuals***

Normality check of residual of the linear regression with transformed dependant variable

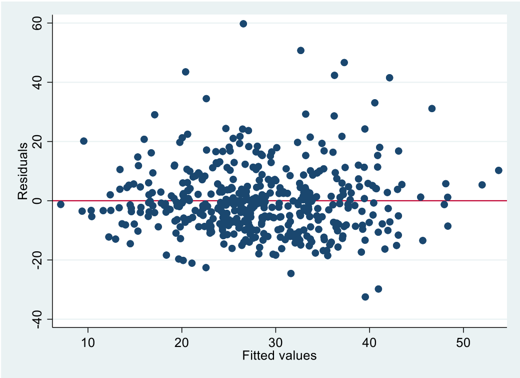


Shapiro-Wilk tests for normal data. If the p-value is significant normality of the residuals is rejected

Variable	**W**	**V**	**z**	**P-value**
Residuals	0.9351	19.897	7.155	<0.000

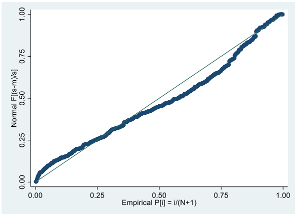
- ***Homoscedasticity of residuals***

Homoscedasticity of residual from linear regression by plotting residual versus fitted values. In a well fitted model, no pattern should be plotted against the fitted valued (red line).

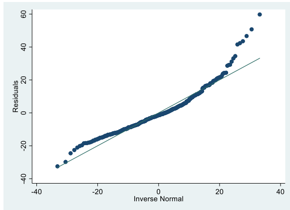


- ***Linearity of residuals***

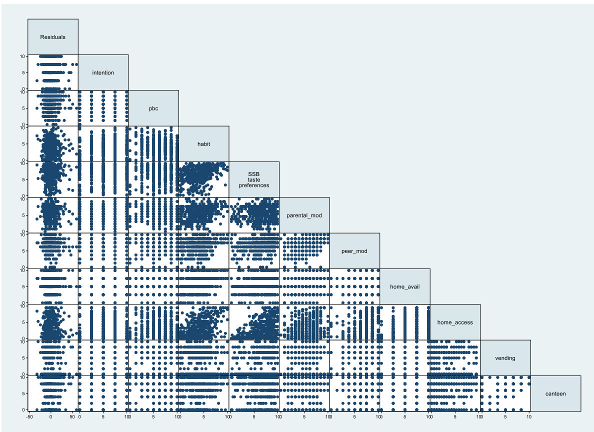
Normal probability plot



Normal quantile plot



Linearity check between residuals and independent variables



Appendix 11: Regression models' comparison

	Linear regression		Linear regression with square root transformation		Negative Binomial		Poisson	
	B	**95% CI**	**B**	**95% CI**	**B**	**95% CI**	**B**	**95% CI**
Gender	-346.5**	[-573.61, -119.43]	-5.18***	[-7.85, -2.52]	-0.37***	[-0.53, -0.20]	-0.37***	[-0.53, -0.21]
Age	21.9	[-46.25,90.11]	0.21	[-1.02,1.45]	0.016	[-0.07,0.10]	0.0097	[-0.06,0.08]
BMI	10.7	[-29.70,51.10]	0.099	[-0.35,0.55]	0.0015	[-0.02,0.02]	0.013	[-0.02,0.04]
SES	-42	[-105.40,21.45]	-0.96*	[-1.79, -0.14]	-0.091***	[-0.14, -0.04]	-0.052	[-0.11,0.01]
Educational level	-727.1*	[-1393.57, -60.68]	-4.16	[-13.19,4.88]	-0.044	[-0.88,0.79]	-0.36	[-0.98,0.26]
Intention	-7.75	[-43.59,28.10]	-0.18	[-0.69,0.33]	-0.017	[-0.06,0.02]	-0.0065	[-0.04,0.03]
PBC	-2.12	[-33.07,28.82]	-0.091	[-0.47,0.29]	-0.0042	[-0.03,0.02]	-0.012	[-0.04,0.02]
Habit	102.4***	[50.11,154.73]	1.75***	[1.29,2.21]	0.11***	[0.08,0.15]	0.099***	[0.05,0.14]
Taste	13	[-36.14,62.12]	0.18	[-0.39,0.75]	0.035*	[0.00,0.07]	0.022	[-0.02,0.06]
Parental modelling	-67.5	[-143.95,8.88]	-0.91	[-1.84,0.02]	-0.056*	[-0.11, -0.00]	-0.053	[-0.12,0.01]
Peer modelling	16	[-25.04,56.95]	0.32	[-0.50,1.15]	0	[0.00,0.00]	0	[0.00,0.00]
Home availability	65.9**	[29.13,102.70]	0.81***	[0.48,1.14]	0.068***	[0.05,0.09]	0.068***	[0.04,0.10]
Home accessibility	44.2*	[9.06,79.24]	0.87**	[0.37,1.37]	0.034	[-0.01,0.07]	0.036**	[0.01,0.06]
School availability -vending machine	45.6**	[14.57,76.59]	0.50**	[0.23,0.76]	0	[0.00,0.00]	0	[0.00,0.00]
School availability -canteen	11.7	[-16.92,40.24]	0.25	[-0.11,0.60]	0	[0.00,0.00]	0	[0.00,0.00]
Educational level vs peer modelling	189.1***	[102.51,275.60]	1.69***	[0.90,2.49]	0.061	[-0.02,0.14]	0.12***	[0.06,0.18]

Educational level vs. school availability vending machines	-148.8***	[-191.50, -106.10]	-1.85***	[-2.54, -1.16]	-0.12***	[-0.20, -0.05]	-0.13***	[-0.18, -0.08]
Educational level vs. school availability canteen	-58.8**	[-95.79, -21.73]	-0.73*	[-1.30, -0.16]	-0.043	[-0.11,0.02]	-0.054	[-0.12,0.01]
Model fit statistics								
R^2	0.23		0.32		N/A		N/A	
BIC	7536		3592		7075		258260	
AIC	7470		3526		7010		258194	

Appendix 12: Logistic regression models

Class	Moderate SSB drinkers (c1)					Average SSB drinker (c2)					High SSB drinkers (c3)				
Proportion	43%					50%					7%				
Total SSBs intercept	1193					374					3339				
Parameter	OR	SE	95% CI		P value	OR	SE	95% CI		P value	OR	SE	95% CI		P value
Gender	2.25	1.7	0.79	6.37	0.13	8.66	1.86	2.57	29.2	<0.001	ref	ref	ref	ref	ref
Age	0.88	1.27	0.54	1.41	0.58	0.85	1.18	0.62	1.19	0.35	ref	ref	ref	ref	ref
BMI	0.98	1.09	0.83	1.15	0.78	0.99	1.09	0.84	1.17	0.91	ref	ref	ref	ref	ref
SES	1.03	1.12	0.83	1.29	0.79	1.41	1.16	1.05	1.89	0.02	ref	ref	ref	ref	ref
Education level	2.49	3.03	0.28	21.8	0.41	4.19	3.07	0.46	37.87	0.20	ref	ref	ref	ref	ref
Intention	1.01	1.12	0.81	1.26	0.91	1.07	1.15	0.81	1.41	0.63	ref	ref	ref	ref	ref
PBC	1.08	1.13	0.86	1.37	0.49	1.03	1.13	0.81	1.31	0.82	ref	ref	ref	ref	ref
Habit	0.81	1.29	0.5	1.34	0.42	0.61	1.19	0.43	0.87	0.01	ref	ref	ref	ref	ref
Taste	0.94	1.12	0.76	1.17	0.59	0.83	1.12	0.67	1.04	0.11	ref	ref	ref	ref	ref
Parental modelling	1.26	1.14	0.98	1.62	0.07	1.47	1.36	0.81	2.67	0.21	ref	ref	ref	ref	ref
Peer modelling	0.98	1.16	0.73	1.3	0.87	0.89	1.16	0.66	1.19	0.43	ref	ref	ref	ref	ref
Home availability	0.77	1.18	0.55	1.07	0.12	0.63	1.16	0.47	0.83	0.001	ref	ref	ref	ref	ref
Home accessibility	0.92	1.09	0.78	1.08	0.31	0.75	1.24	0.49	1.14	0.18	ref	ref	ref	ref	ref
School availability vending machines	0.81	1.08	0.69	0.95	0.008	0.81	1.1	0.67	0.97	0.02	ref	ref	ref	ref	ref
School availability canteen	1.03	1.14	0.79	1.33	0.85	0.97	1.11	0.79	1.18	0.75	ref	ref	ref	ref	ref

Class	Moderate SSB drinkers (c1)					Average SSB drinker (c2)					High SSB drinkers (c3)				
Proportion	43%					50%					7%				
Total SSBs intercept	1193					374					3339				
Parameter	OR	SE	95% CI		P value	OR	SE	95% CI		P value	OR	SE	95% CI		P value
Gender	0.26	1.6	0.1	0.66	0.004	ref	ref	ref	ref	ref	0.12	1.86	0.03	0.39	<0.001
Age	1.02	1.2	0.72	1.45	0.90	ref	ref	ref	ref	ref	1.17	1.18	0.84	1.62	0.35
BMI	0.99	1.01	0.96	1.01	0.23	ref	ref	ref	ref	ref	1.01	1.09	0.85	1.19	0.91
SES	0.73	1.1	0.61	0.88	0.001	ref	ref	ref	ref	ref	0.71	1.16	0.53	0.95	0.02
Education level	0.59	2.32	0.11	3.09	0.54	ref	ref	ref	ref	ref	0.24	3.07	0.03	2.16	0.20
Intention	0.95	1.16	0.71	1.26	0.71	ref	ref	ref	ref	ref	0.93	1.15	0.71	1.23	0.63
PBC	1.05	1.08	0.91	1.22	0.47	ref	ref	ref	ref	ref	0.97	1.13	0.76	1.24	0.82
Habit	1.33	1.1	1.11	1.59	0.002	ref	ref	ref	ref	ref	1.63	1.19	1.15	2.3	0.01
Taste	1.13	1.05	1.02	1.25	0.02	ref	ref	ref	ref	ref	1.2	1.12	0.96	1.5	0.11
Parental modelling	0.86	1.21	0.59	1.24	0.41	ref	ref	ref	ref	ref	0.68	1.36	0.37	1.24	0.21
Peer modelling	1.1	1.15	0.84	1.44	0.50	ref	ref	ref	ref	ref	1.12	1.16	0.84	1.51	0.43
Home availability	1.23	1.09	1.05	1.44	0.01	ref	ref	ref	ref	ref	1.6	1.16	1.2	2.12	0.001
Home accessibility	1.23	1.17	0.9	1.68	0.19	ref	ref	ref	ref	ref	1.34	1.24	0.88	2.05	0.18
School availability vending machines	1	1.04	0.93	1.09	0.93	ref	ref	ref	ref	ref	1.24	1.1	1.03	1.49	0.02
School availability canteen	1.06	1.06	0.95	1.18	0.30	ref	ref	ref	ref	ref	1.03	1.11	0.84	1.26	0.75

Class	Moderate SSB drinkers (c1)					Average SSB drinker (c2)					High SSB drinkers (c3)				
Proportion	43%					50%					7%				
Total SSBs intercept	1193					374					3339				
Parameter	OR	SE	95% CI		P value	OR	SE	95% CI		P value	OR	SE	95% CI		P value
Gender	ref	ref	ref	ref	ref	3.85	1.6	1.52	9.74	0.004	0.45	1.7	0.16	1.26	0.128
Age	ref	ref	ref	ref	ref	0.98	1.2	0.69	1.39	0.897	1.14	1.27	0.71	1.84	0.58
BMI	ref	ref	ref	ref	ref	1.02	1.01	0.99	1.04	0.225	1.02	1.09	0.87	1.21	0.779
SES	ref	ref	ref	ref	ref	1.37	1.1	1.13	1.65	0.001	0.97	1.12	0.78	1.21	0.787
Education level	ref	ref	ref	ref	ref	1.68	2.32	0.32	8.75	0.536	0.4	3.03	0.05	3.52	0.41
Intention	ref	ref	ref	ref	ref	1.06	1.16	0.8	1.4	0.705	0.99	1.12	0.79	1.23	0.909
PBC	ref	ref	ref	ref	ref	0.95	1.08	0.82	1.09	0.467	0.92	1.13	0.73	1.16	0.492
Habit	ref	ref	ref	ref	ref	0.75	1.1	0.63	0.9	0.002	1.23	1.29	0.75	2.02	0.42
Taste	ref	ref	ref	ref	ref	0.88	1.05	0.8	0.98	0.021	1.06	1.12	0.85	1.32	0.591
Parental modelling	ref	ref	ref	ref	ref	1.17	1.21	0.81	1.68	0.406	0.79	1.14	0.62	1.02	0.074
Peer modelling	ref	ref	ref	ref	ref	0.91	1.15	0.7	1.19	0.501	1.02	1.16	0.77	1.36	0.869
Home availability	ref	ref	ref	ref	ref	0.81	1.09	0.69	0.96	0.012	1.3	1.18	0.93	1.81	0.119
Home accessibility	ref	ref	ref	ref	ref	0.81	1.17	0.59	1.11	0.192	1.09	1.09	0.92	1.28	0.313
School availability vending machines	ref	ref	ref	ref	ref	1	1.04	0.92	1.08	0.93	1.24	1.08	1.06	1.45	0.008
School availability canteen	ref	ref	ref	ref	ref	0.94	1.06	0.85	1.05	0.301	0.98	1.14	0.75	1.26	0.85

Appendix 13: Interview invitation

SE BUSCAN PARTICIPANTES

Hola

¿Recuerdas que el año pasado participaste en una investigación donde completaste un cuestionario en línea?

Al final del cuestionario mostraste tu interes en seguir participando con la sigueinte parte del proyectio proporiconandos tu e-mail.

Por esta razon te queremos invitar a participar en una entrevista con uno de los investigadores, ya que nos gustaría platicar contigo para aprender un poco mas de las bebidas que consumes diarimente.

La entrevista sera como una conversacion informal que durara entre 30 a 60 minutos .

En forma de agradecimiento por tu tiempo recibiras $100 pesos al finalizer la entrevista.

Si estas interesado(a) en participar, por favor responde a este correo electrónico: **a.ortegaavila@bristol.ac.uk**

Si tienes alguna duda o quieres comunicarte con Mtra. Ana Ortega lo puedes hacer a este número:
Celular y **Whatsapp: 6623724943**

University of BRISTOL

Appendix 14: Information sheet

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School for Policy Studies
8 Priory Road
Bristol BS8 1TZ
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E-mail: a.ortegaavila@bristol.ac.uk

PARTICIPANT'S INFORMATION SHEET

As part of a PhD project the Centre for Exercise, Nutrition and Health Sciences in the School for Policy Studies at Bristol University, we are conducting a Beverage Intake research study in the city of Hermosillo, Mexico. You participated in a previous study where you completed an online survey and where you showed interest in participating in future research. For this reason, we are inviting you to take part in the second stage of our research. The project has full ethical approval from University of Bristol's School for Policy Studies Research Ethics Committee

What is the project about?

The purpose of this project is to explore the consumption of beverages in adolescents in depth, as well as the reasons determining beverage consumption at home and school environments. This valuable information will help us to develop effective interventions to promote healthy eating habits among adolescents in Mexico.

What will I need to do if I take part in your study?

You will be asked to participate in a one-to-one interview. The interview will be with one of the researchers (Ana Ortega) and will last up to 60 minutes. The interviewer will ask you questions related to:

1) Non-alcoholic beverages you like to drink.
2) Non-alcoholic beverage you consume at home, school/university and outside home and school/university
3) Also, we are interested to hear your reasons to drink the beverages.

What happens to the information I provide?

It is important that you know that the interview will be digitally-recorded and transcribed, but your name will never appear in any written report. All information which is collected will be kept strictly confidential; your teachers, parent/guardian or class mates will not see any of your answers. This information will only be used by the research team and will not be used for any other purposes**.**

Results of this research will be part of the researcher doctoral thesis and they will get published in scientific journals. All information will be kept securely at the University of Bristol. All data will be stored for 20 years anonymously on a password protected computer in accordance with the Data Protection Act for the use by other researchers.

What are the benefits of taking part in the study?

The results we get from this study will help us understand the reasons determining beverage consumption among adolescents. This information will also help us to develop successful approaches to promote healthy eating in adolescents in the city of Hermosillo, from which both you and your mates can benefit in the future. As compensation for your time to take part in an interview you will receive 100 Mexican pesos after the interview is completed.

Are there any risks involved in taking part in the study?

The specific procedures of this study carry no risk of physical or psychological harm.

Do I have to take part in the study?

Your consent and participation in an interview are totally voluntary. If you decide that you will participate in an interview, you can stop taking part at any time and without giving any reason. However, once you participated on an interview and you decide you want to withdraw the information you provided you will have until the 15th June 2016 to do so.

Thank you for reading this Information Sheet. We hope that you will be able to take part in the interviews and if you have any further queries, please don't hesitate to contact us.

Ana G. Ortega Avila

E-mail: a.ortegaavila@bristol.ac.uk

For any complaints regarding this research please contact Professor Russell Jago at Russ.Jago@bristol.ac.uk or Dr Angeliki Papadaki at Angeliki.Papadaki@bristol.ac.uk

Appendix 15: Interview questioning guide

Home
Can you describe what beverages you and your family drink at home? *If I go to your house, what beverages can I find in the fridge?*
Who buys or prepares these beverages in your home?
Where do these beverages normally purchase?
When you, your parents or other family members buy SSBs, what amounts are normally bought? *Just one bottle/ A few bottles for the week/ A big box// only what we need for that day.*
What are the reasons for buying/preparing these beverages at home?
How does your family decide what they want to buy/prepare to drink? *Do you decide this as a family, or is it an individual choice?*
How important is it for you or your family to have sugary drinks at home? *Why do you think it matters (or not)?*
How similar or different are your drinking preferences in relation to your parents/family? *Why is that?*
Do you drink these kinds of beverages with any member of your family? *Do you share SSBs as a family at home?* *During meals, family time at, weekends?*
How much freedom do you have to decide what you want to drink in your house? *Would you say that your parents usually tell you what to drink?*
How much do you think your family have influenced you about what you drink? *Why do you think that?*
Do you or your family have SSB tradition? Have you or your family have drinking SSBs for many years?
When you are at home, how long do you take to decide what you are going to drink?
Instruction: Ask if sugary drinks are not often available at home
Why do you think are the reasons that SSBs are not available in your home? *Is there a family rule, do your parents/ family not drink SSBs?*
School
What do you normally drink when you are at school?
How would you describe your usual consumption of SSBs at school?
Is there a difference between what you drink at home and school? *Why do think is that?*

Where do you get these drinks (mention the one they usually drink)?

Do you buy them at school?

If they buy at school:

Can you tell me where in school you normally buy SSBs (or the beverages they usually drink?

vending machines, canteen etc

If they don't buy at school:

Is there any particular reason why you don't buy SSBs at school?

Why do you bring them from outside the school?

Do your peers drink beverages similar to the ones you drink a school?

When you are at your school, do you think your consumption is influenced by your peers?

In what ways do they influence your choices?

Do you feel freer to drink the SSBs you like the most at school than at your house*?*

Why do think is that?

Are any street vendors outside your school/university?

If yes:

How far?

Do you buy beverages from them?

If yes:

Why do you buy beverages form street vendors?

Is any convenience stores near your school/university?

If yes:

How far?

Do you go often there to buy beverages?

If yes:

Why do you buy beverages at convenience store?

How convenient is for you to have a shop near your school?

Why is it (or not) convenient?

What kind of beverages you drink when you are not at home or at school?

Where do you buy SSBs from?

Corner shops, supermarket, street vendors

With whom do you typically drink SSBs outside home/school?

friends, girlfriend/boyfriend, family etc.

In what way do you think your friends affects what or how much you drink outside your house and school?

Taxation

Do you know about the taxation of sugar drinks in Mexico?

If the answer is yes: *Tell me what you know about it. Where did you hear about the tax? Do you know why the price went up? Do you know by how much?* If the answer is no, explain: *In Mexico, the price of sugar containing beverages increased by 10%. So for example, if a 1 litre bottle of soft drink increases in price by 10%, it means that instead of you paying 10 pesos you will pay 11 pesos.*
Tell me about how the increase in the price of sugary drinks has affected how often you buy/drink them. *Do you think this increase in the price would affect how often you buy/drink sugary drinks?*
Would you stop buying SSBs because of the tax? *Why do you think that is?*
Would you buy anything else instead? What would you drink instead of sugary drinks?
Do you think the tax will reduce intake of sugary drinks? *Why do you think that is?*

Appendix 16: Consent form

University of BRISTOL

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CONSENT FORM FOR ADOLESCENTS

Please read each statement and write your initials in the space provided if you agree:

- I confirm that I have read and understood the information sheet. ☐
- I confirm that I have had the opportunity to ask questions about this study and if so, I have received satisfactory answers to all my questions ☐
- I understand that my participation in the interview is voluntary and that I am free to stop taking part at any time and without giving any reasons ☐
- I understand that the interview will be digitally recorded, that notes will be taken during the session and that recordings will be transcribed. My name will never be included in any reports and only anonymised quotes will be used for publication purposes. Any files containing information about me will be anonymised, will be treated as confidential and will be stored in University of Bristol password-protected computers. Recordings will be deleted following transcription. At the end of the project data will be stored for 20 years in appropriate storage facilities. ☐
- I agree to the University of Bristol recording and processing this information and I understand that this information will be used only for the purposes of this study. My consent is conditional upon the University complying with its duties and obligations under the Data Protection Act. ☐
- I agree to participate in an interview for this study ☐

Please sign and date here

Name	**Signature**	**Date**

Appendix 17: Framework matrix

Home availability of SSBs	Importance of having SSB at home	Purchase and preparation	Decision making	Family changes on SSB overtime	Family influence for SSBs intake	Family preferences	Family regulation of SSBs	Habit and family norms
a veces no todos dias cómo una vez por semana, pues de que a mis hermanas se les antoja y van compran un refresco de naranja			PADRES deciden juntos que va a ver de tomar o nunca les preguntan o cómo es? P: no nunca preguntan		SIBLINGS a veces no todos dias cómo una vez por semana, pues de que a mis hermanas se les antoja y van compran un refresco de naranja	PARENTS mis papas si le gusta mucho ósea si le gusta la soda	y por ejemplo deciden juntos que va a ver de tomar o nunca les preguntan o cómo es? P: no nunca preguntan ¿tú tienes la libertad de escoger que quieres tomar en tu casa aparte de agua y la leche?, P: si ya lo he hecho varias veces	
aguas frescas endulzado con azucar moscabado, limonada rosa en polvo, nestea	pue si ósea, si mi familia como que procuran que sean sanas				ósea si compran a veces o si traen antojo una soda, pero pues no es de que muy seguido crees que de cierta forma tu familia o tus papas u otro miembro de familia han influenciado lo que te gusta tomar?	PARENTS mi mama si le gusta la coca verde la light FAMILY tomamos lo mismo que limonada que la jamaca que esas cosas	sí de hecho una vez, por ejemplo, me gusta de sodas, me gusta la sangría la coca la de limón y había en mi casa y una vez me la lleve a la escuela y ni al caso	

aguas de sabor, esas para preprar en sobre I aja las que son en polvo p aja... que más... soda, leche, que más agua natural	pues importante porque sirve para hidratarte que no?		TODOS normalmente las elegimos en familia para ver toma esta y quien no		FAMILIA pues mucho porque de lo que sé que puedo tomar es porque está en mi casa, porque los compra mi familia pues	*No hablo mucho de la preferencias de su familia*	p la mayoría es si mi mama quiere tomar algo lo compra, cada quien elige lo que quiere tomar entonces crees que tienes libertad de cuales bebidas tomar en tu casa? p si I no tienes restricciones de ningún tipo. p no	HABIT tradición familiar consumir bebidas de este tipo en tu casa? p pues si, a la hora de comer compran la soda
todo está enfocado en la coca cola en mi casa, es lo que se toma para comida al día nomas	cuáles crees que sean la razón de tu familia de tus papás para comprar o para tomar tanta Coca? ¿crees que tenga una razón específica ellos? p el sabor, el gas		pero todos eligen		p si i ¿por qué crees que ha influenciado? p porque ellos me dieron a probar el té helado y la Coca-Cola la deje de tomar por un familiar que tiene diabetes por eso.	FAMILIA ellos toman coca... por el sabor, el gas	libertad en decidir tu que tomar en tu casa p si ¿no tienen restricción de ningún tipo? y si quieres tomar otra cosa… p si me dejan	FAMILY NORM lo han hecho desde que te acuerdas, desde que estabas chico ¿siempre ha sido asi? p si siempre Coca porque mi padre antes trabajaba en Coca-Cola

En las tardes pues solo estamos comprando lo que es la coca cola, de que vamos a comer esto coca cola y aveces mi mama llega hacer aguas naturales de que mango jamaica limonada, que mas? p jugos (Jumex), tal vez una soda que se quedo ahi , la leche .	CHECAR AUDIO ORIGINAL yo usualmente me sirvo jugo, para hacer la tareas o estar en el cuarto viendo la tele si no hay es de que 'mama que hay para toma?'y tengo que ir a la tienda pues por que compro jugo no es co o que voy a comprar una soda. si es para ti personalmenet si es crees que es muy necesario? p si jajaja		por ejemplo yo compro y lo demas toman , yo lo hecho al carrito, ah esta bien o voy a hechar esto o lo otrso, no es de yo compro y nada mas para mi lo que hay en refri es para todos		veces de que cuando ven que alguien est aprperandos e algo ah sabes que a mi tambien sirveme y ... tal vez o en las fotos de que s eantojo eso quiero esto La coca cola es la que si de plano es familiar , mi papa la toma, mi mama la toma pues yo la temrino tomando	MAMA y yo y mama soda o o un jugo	p en la escuelaaa, bueno no en la casa por que ahi nadie me esta juzgando y tomo lo que quiero	La coca cola pues es familiar todos se sirven noreimos bien comercial de cocacola jaja La coca cola es la que si de plano es familiar , mi papa la toma, mi mama la toma pues yo la temrino tomando
agua, jugo de durazno, piña o mango ,los yogurt u rara vez una soda	i por que aveces se antoja , hay quieor algo dulce, voya tomar jugo		nadie dice se va atomar esto tomar p no es, es lo que quieran tomar ahi pues mi papa lo compra cuando va a al supe ry ahi va estar	pues ultimamente si, antes no comprababan jugos era pura agua pero siempre una soda de 2 litros si era ley que estuviera la soda de 2 litros pero eso fue cambiando y y ahora son puro jugos.	SIBLINGS si ,por ejemplo la coca cola con mi hermano mi hermano siemrpe toma soda, es la priemra opcion soda una coca cola, es lo que siempre toma y tambien el jugo	MAMA mi mama toma agua pero pero toma mas soda light y jugo de durzno igual que yo por que ahi tenemos nuestros botecitosy ya nos estamos sirviendo	p yo digo que desde que tengo memoria por que nunca me han dicho no tomes eso lo que son bebidas que me pueden alterar el corazon , por ejemplo los red bull monstesr nunca me han dejado tomarlo y no son de mi agrado pero siempre yo he elegido lo que quiero tomar	